# STS-114 / LF1
# Flight Readiness Review


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**June 29, 2005**

# Agenda

- **STS-114 / LF1 FRR – B.Z. Johnson**
  - EVA Mission Overview
  - EMU and SAFER Logistics
  - EMU Status
  - SAFER Status
  - EVA Tools and Crew Aids Status
  - Forward Work
- **EVA Office Special Topic**
  - Airlock and EMU Recovery Status – J. Lewis

# EVA Mission Overview

- **EVA Capability**
  - EVA consumables to support
    - Three scheduled EVAs conducted from the Shuttle Airlock
    - Two contingency EVAs for Remote Manipulator System (RMS), Orbiter Docking System (ODS), and Orbiter contingencies including TPS inspection and repair
- **EVA Crew**
  - EV1: Soichi Noguchi
  - EV2: Steve Robinson
- **EVA Training**
  - Crew is fully trained on all required EVA tasks
    - All EVA 1, 2, and 3 tasks can be accommodated within scheduled 6 hour 30 minute timelines
  - Crew is trained to perform contingency EVAs for RMS, ODS, and Orbiter contingencies including TPS inspection and repair
    - TPS repair procedures are maintained on the ground to support real-time requirements
    - Additional work required real-time to finalize procedures for both tile and RCC repair

# EVA Mission Overview (cont.)

- **EVA 1 (Flight Day 5) – 6 hours 30 minutes**
  - Thermal Protection System DTO
    - Perform Tile Repair Emittance Wash and RCC Crack Repair NOAX demonstrations
  - ESP-2 Attachment Device (ESPAD) Installation
    - Remove ESPAD from the ESP-2 in the Payload bay and install it onto the ISS Airlock
  - Global Positioning Satellite (GPS) Antenna Remove and Replace (R&R)
    - Remove and replace GPS Antenna #2 on S0 truss
  - Z1 Patch Panel Reconfiguration
    - Reconfigure cables to restore power to Control Moment Gyro (CMG) 2
  - CMG R&R Prep Tasks
    - Temp stow Node light stanchion
    - Configure hardware and tools
  - ESP-2 Power Cable Routing
    - Route primary and secondary power cables from S0 truss and the Node to ESP-2

# EVA Mission Overview (cont.)

- **EVA 2 (Flight Day 7) – 6 hours 30 minutes**
  - Control Moment Gyro (CMG) R&R
    - Pull back and restrain Z1 thermal shroud
    - Remove failed CMG from Z1
    - Crewmember on SSRMS translates failed CMG to Payload bay
    - Temp stow failed CMG in Payload bay
    - Remove new CMG from Flight Support Equipment (FSE) and temp stow in Payload bay
    - Install failed CMG in to FSE
    - Crewmember on SSRMS translates new CMG to Z1 worksite
    - Install new CMG on Z1
    - Close Z1 thermal shroud

# EVA Mission Overview (cont.)

- **EVA 3 (Flight Day 9) – 6 hours**
  - External Television Camera group (ETVCG) Installation
    - Remove Video Stanchion Support Assembly (VSSA) from ESP-2
    - Install VSSA and ETVCG #3 at Camera Port #9 on P1 truss outboard, nadir tip
  - ESP-2 Installation
    - SSRMS removes ESP-2 from the Payload Bay and maneuvers it to ISS Airlock
    - Crew secures ESP-2 to active ESPAD for final installation
  - Materials ISS Experiment (MISSE) Payload Experiment Container (PEC) Installation
    - Install MISSE PEC 5 on P6 truss
  - MISSE Payload Experiment Container (PEC) Retrieval
    - Retrieve PECs 1 and 2 from ISS Joint Airlock exterior location
  - Flight Releasable Grapple Fixture (FRGF) removal from ESP-2
    - Stow in Starboard TSA for return

# EMU and SAFER Logistics

- **Four EMU's launched and returned on LF1**
  - Flying two Large EMUs up and down for Shuttle crew
  - Launching two EMUs for transfer to ISS (Large and X-Large)
  - Returning two EMUs currently on-board
- **Increment 11 EMU hardware for Philips and Krikalev left on ISS post LF1**
  - One Large and one X-Large EMU
  - One expired EMU remains on-orbit for IVA use only
- **SAFER Rotation**
  - Rotating two SAFERs
    - One launches in Middeck / One launches in MPLM
  - Three SAFERs on-orbit post LF1
    - One is expired and will be replaced on ULF1.1

# EMU Status

- **Significant EMU first flight hardware**
  - Tile Repair Backpack Frame
    - Attaches Cure-In-Place Ablator Applicator (CIPAA) backpack to EMU
  - SAFER Hand Controller Module Hard Mount
    - Provides single handed SAFER operation during TPS inspection
  - O2 Actuator Switch Cover
    - Prevents ablator material from jamming EMU O2 Actuator
  - EMU Equipment Bag
    - Redesigned bag replaces current Airlock Stowage Bag
    - Composed of one generic section and two detachable crew member specific sections
  - Updated EMU Servicing Kit
    - Deleted alcohol wipes due to ISS on-orbit alcohol ban and replaced them with shaving cream, soap, and razors to prepare crewmember skin for bio-med system electrode attachment
  - Replacement Fan/Pump/Separator Rotor Epoxy (STS-114)
    - Implements rotor with new epoxy; previously used material is no longer available
  - Airlock Coolant Loop Recovery Kit
    - Ensures cleanliness of ISS Airlock / EMU coolant loops

# EMU Status

- **EMU Hazard Reports / CILs / Waivers**
  - All EMU Hazard Reports and CILs have been re-reviewed and approved by the appropriate Program and the Independent Technical Authority (iTA)
  - All Program Level EMU Waivers have been reviewed and dispositioned by the Shuttle Program, NESC, and iTA
  - All Level Three EMU Waivers have been reviewed and dispositioned as required
    - No increased safety risk
- **EMU Open Certification**
  - None
- **EMU Open Failures**
  - None

# EMU Status

- **Significant EMU Analysis**
  - EVAM-0051: Official memo released by Hamilton Sundstrand documenting EMU compatibility with NOAX RCC crack repair material
    - No adverse impact to suit function or thermal performance
  - EVAM-0084: Official memo released by Hamilton Sundstrand documenting EMU compatibility with tile repair materials including Shuttle Tile Ablator-54 (STA-54) and Emittance Wash
    - No adverse impact to suit function or thermal performance

# SAFER Status

- **SAFER Certification**
  - Hardware Certification is Complete
- **SAFER Waivers and Anomalies**
  - Hardware has been redesigned to eliminate Program level bend radius waiver
  - Waiver will be retired when on-orbit units are returned
- **SAFER first flight hardware**
  - New configuration (-315)
    - Modification of Hand Controller Module to interface with hard-mount mechanism
    - Minor system upgrades

# EVA Tools and Crew Aids Status

- **EVA Tools and Crew Aids First Flight Items (48 new items)**
  - EVA Digital Camera Bracket and Camera Mounting Assembly
    - Enable use of new EVA Digital Camera
  - 85-FT Safety Tether
    - Developed for TPS repair/inspection but certified for generic ISS use
  - Orbiter Slide Wire
    - Installed thermal cover to improve slide wire thermal performance and factor of safety
  - Pistol Grip Tool (PGT) Torque Analyzer Kit (TAK)
    - IVA hardware used to check calibration of on-orbit PGTs
  - Contamination Detection Kit (CDK)
    - Adds ammonia detection capability
  - WIF Extender
    - Improves EVA access to hardware stowed on ESP-2
  - Locking Crew Hooks
    - Increases fault tolerance to prevent inadvertent release

# EVA Tools and Crew Aids Status

- **Tile Repair Tools**
  - Contingency tools with no planned use on STS-114 being certified as Safe-to-Fly/Safe-to-Use
    - Cure In-Place Ablator Applicator (CIPAA) System
      - Cure In-Place Ablator Applicator (CIPAA) Main Unit
      - Hose Manifold Gun (HMG)
      - Holster (Gun Holster)
      - CIPAA Cleaning Kit
      - CIPAA Containment Bag
    - Tile Repair Hand Tools & Crew Aids
      - Contour Gauge
      - Durometer Assembly and Test Kit
      - 1” and 3” Foam Brushes with Removable Handles
      - Silicone Gel Brush Kit with 1”, 3”, and Pencil Tip Brushes
      - CIPA Discard Container
      - 3” Scraper
      - Angled and Flat Stamps
      - Tile Repair Kit (TRK) Stowage Bag
  - Tools used to perform TPS DTO on STS-114 being certified as Safe-to-Fly/Safe-to-Use
    - Emittance Wash Applicator Kit
    - EVA Wipe
    - Mini-Workstation (MWS) Tool Stowage Caddy

# EVA Tools and Crew Aids Status

- **RCC Repair Tools**
  - Contingency tools with no planned EVA use on STS-114 being certified as Safe-to-Fly/Safe-to-Use
    - RCC Plug Repair Tools
      - EVA Marker
      - Ruler / Protuberance Gauge
      - Large EVA Drill
      - Small EVA Drill
      - Plug Installation Tool
      - EVA Gap Gauge (10/20)
      - EVA Gap Gauge (30/35)
  - Tools used to perform TPS DTO on STS-114 being certified as Safe-to-Fly/Safe-to-Use
    - RCC Crack Repair Tools
      - Manual Crack Repair Gun
      - EVA Thermal Sensor
      - Crack Repair Bag
      - Crack Repair Palette
      - 2” and 5” Crack Repair Material Scrapers

# EVA Tools and Crew Aids Status

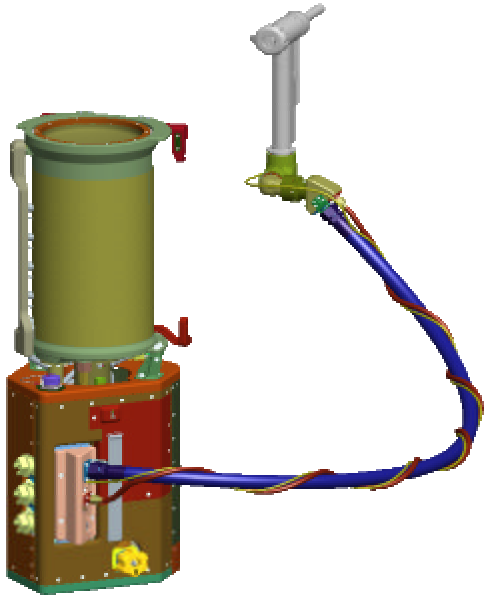
- **Open Certification of EVA Tools with Planned Use on STS-114**
  - RCC NOAX Crack Repair DTO Tools
    - Certification packages are in the signature cycle
      - Manual Crack Repair Gun – ECD July 6, 2005
      - Crack Repair Bag – ECD July 8, 2005
      - RCC 2” and 5” Scrapers – ECD July 1, 2005
      - MWS Tool Stowage Caddy – ECD June 29, 2005
      - EVA Thermal Sensor – ECD July 1, 2005
  - Tile Repair Emittance Wash DTO Tools
    - Certification packages are in the signature cycle
      - Emittance Wash Applicator (EWA) Kit - ECD July 6, 2005
      - EVA Wipes – ECD July 1, 2005

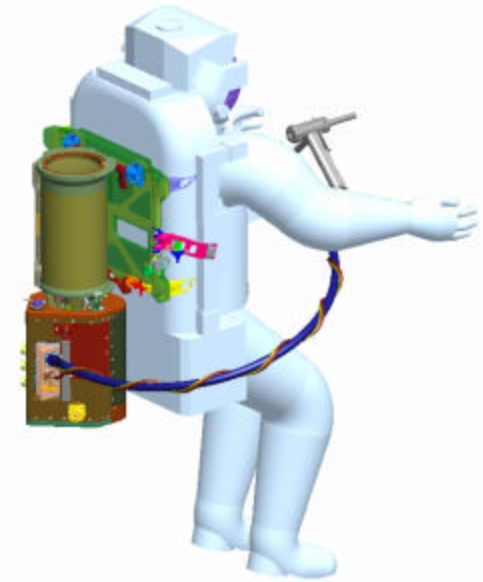
# EVA Tools and Crew Aids Status

- **Open Certification for Contingency TPS Repair EVA Tools with No Planned Use on STS-114**
  - CIPAA System - Certification ECD: July 8, 2005
    - CIPAA Main Unit
      - All acceptance testing has been completed
      - Hardware has been shipped to Denver and will be filled and shipped to KSC pending direction based on new failure investigation
    - CIPAA Hose Manifold Gun Assembly, Holster, CIPAA Cleaning Kit
      - All testing has been completed and hardware delivered
    - CIPAA Containment Bag
      - CIPA has been designated as tox level 4 based on recent toxicology studies
      - Engineering is concluding an accelerated design effort of a containment bag which meets Program requirements for tox 4 levels of containment
        - » Per requirements, bag provides venting capability with a chemical filter and an indicator for CIPA Part B leakage
      - Certified hardware to be delivered NLT July 8, 2005 in support of nominal CIPAA stow

# CIPAA Description

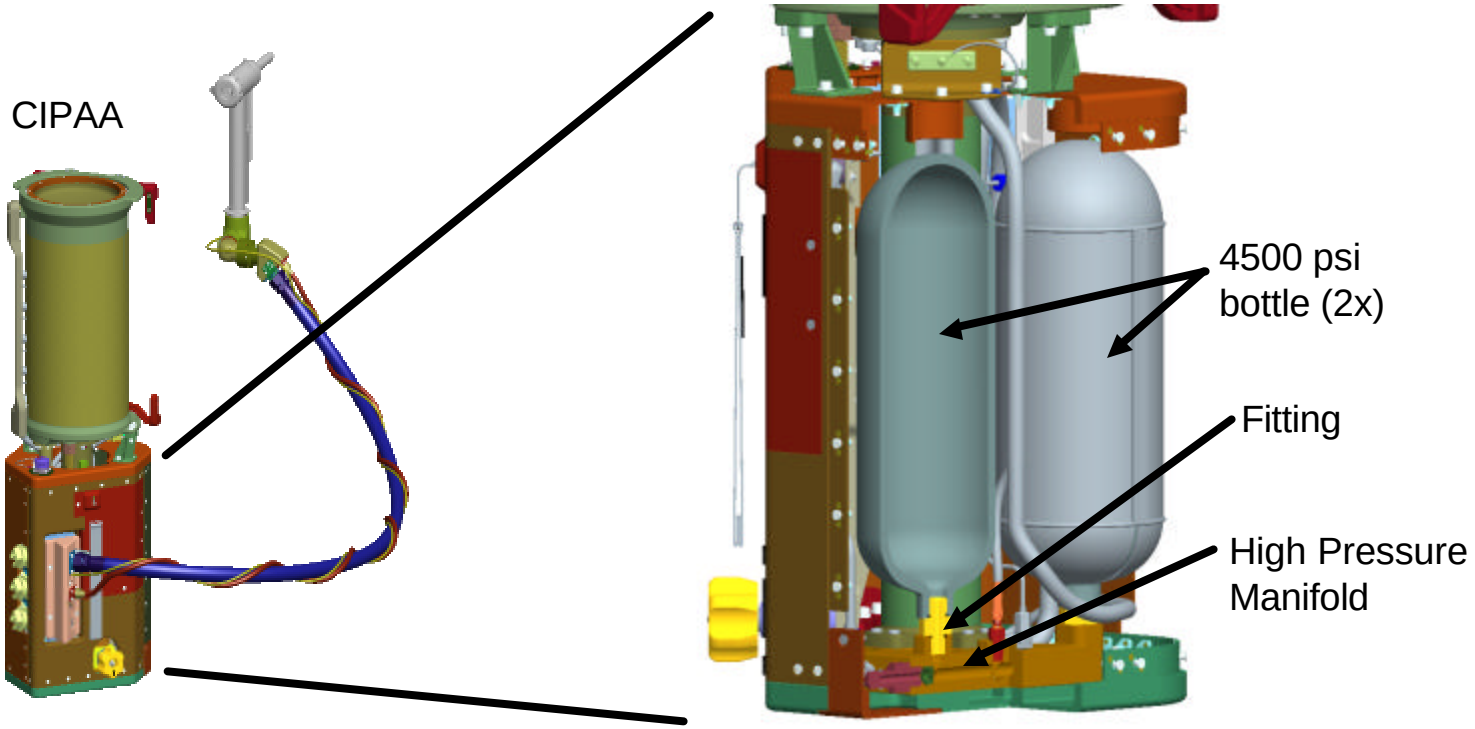
- **CIPAA (Cure In Place Ablator Applicator) MAIN UNIT ASSEMBLY**
  - Ablator parts A and B stored in Inconel and 316 stainless steel reservoirs.
  - Gaseous Nitrogen (GN2 ) is used to dispense the ablator
- **HOSE MIXER GUN (HMG) ORU ASSEMBLY**
  - 5-foot hoses attach as an IVA-ORU at a manifold on the CIPAA main unit
  - 8 static mixer elements are used, 2 in the mix block, 6 in the gun handle
  - The gun is the operator valve for the ablator dispense





# Failure Description

- **CIPAA Qualification unit failed qualification vibration testing on 6/27**
  - CIPAA depressed on the order of 1000psi per minute
  - Post test hardware inspection revealed that one of the two 4500 psi nitrogen bottle fittings had backed out of the high pressure manifold a sufficient distance to depress the system



# Forward Plan

## ❑ Pursue two parallel options

- Option 1 - Analysis of acceptance and qualification vibration loads test regime and results of tests already completed to evaluate flight hardware acceptability as is for one or more flights
  - ✓ CIPAA hardware failed qualification vibe in the 10th minute of the 3rd axis (test was 12 minutes each axis)
  - ✓ Vibe length was derived to certify the CIPAA for 25 missions
  - ✓ CIPAA was hard mounted for vibe test, but will be soft stowed for flight
- Option 2 – Add secondary locking feature to maintain preload of high pressure manifold/fitting and fitting/N2 bottle interfaces on the CIPAA qualification unit, redo vibe test and then update the flight units.
  - ✓ Would not impact flight units fill on 6/29
  - ✓ Fix on flight units would need to be in place NLT 7/2 to avoid impact to existing stowage schedule

# Forward Plan (Cont'd)

- Down select option or hybrid of options by COB 6/29
- Report final closure details at L-2 review

# EVA Tools and Crew Aids Status

- **Open Certification for Contingency TPS Repair EVA Tools with No Planned Use on STS-114**
  - CIPAA System - Certification ECD: July 8, 2005
    - Hazard Reports remain open
      - CIPA Contamination of the Vehicle - Hazard Report has been through Safety review process and will be closed pending submittal of materials memos
      - CIPA Toxicity - Hazard Report returning to Joint Safety Review Panel for Safety approval; requires PRCB approval for final closure

# EVA Tools and Crew Aids Status

- **Open Certification for Contingency TPS Repair EVA Tools with No Planned EVA Use on STS-114**
  - Tile Hand Tools
    - CIPA Discard Container and Durometer – Certification ECD July 1, 2005
      - Certification packages are in the signature cycle
    - Gel and Foam Brush Kits – Certification ECD July 6, 2005
      - Certification package is in the signature cycle
      - Hazard Report for inadvertent release of brush heads requires PRCB approval for closure
    - Mechanical Contour Gage – Certification ECD July 8, 2005
      - Certification package will be routed for signature July 1. 2005
  - RCC Hand Tools
    - Gap Gauges and Drills - Certification ECD July 11, 2005
      - Certification packages will be routed for signature June 29, 2005

# EVA Tools and Crew Aids Status

- **EVA Tools and Crew Aids Hazard Reports / CILs / Waivers**
  - All EVA Tools and Crew Aids Hazard Reports and CILs have been re-reviewed and approved by the appropriate Program and the Independent Technical Authority (ITA)
  - There are no Program Level EVA Tools and Crew Aids Waivers
  - All Level Three EVA Tools and Crew Aids Waivers have been reviewed and dispositioned as required
    - No increased safety risk
- **Open EVA Tools and Crew Aids Failures**
  - CIPAA GN2 leak experienced during qualification vibration testing June 27, 2005. Failure investigation is on-going.

# EVA Tools and Crew Aids Status

- **External Hardware Summary**
  - Lightweight Port TSA
    - Standard Shuttle Contingency Tools
    - Tile Repair Kit (TRK) – TPS Contingency Tools
  - Lightweight Starboard TSA
    - Launch Configuration
      - ESP-2 Power Cables
    - Return Configuration
      - ESP-2 Flight Releasable Grapple Fixture (FRGF)
  - Bay 12 Port Sill Stack
    - High Strength Bridge Clamp, Passive WIF Adapter
    - Provides a worksite for DTO
  - Fwd Bulkhead PFR
    - Supports contingency EVA TPS inspection from the OBSS
  - Port Slide Wire only
    - Starboard Slide wire deleted due to OBSS interference

# EVA STS-300 Readiness

- **The EVA Office has no known constraints to the LON mission**
  - STS-300 Tools Status
    - Standard complement of TPS hardware
      - Open certifications will be closed prior to STS-114
      - All non-limited life hardware can be delivered in support of STS-300 L-10 Bench Review
      - Ability to deliver 2 CIPAA units is dependent on the results of the new CIPAA failure investigation
  - STS-300 EMU Status
    - Two EMUs launched for shuttle contingency

# STS-114 / LF1 FRR Planned Forward Work

| | Title | Definition | Org | Due Date | Risk |
|---|---|---|---|---|---|
| PFW | Complete certification of CIPAA System | Close Hazard Reports, Failure, and Certification paperwork for CIPAA System | XA/EC | 07/06/05 | High |
| PFW | Complete TPS h/w certification | Close Hazard Reports and Certification paperwork for TPS hardware | XA/EC | 07/08/05 | Low |
| SOW | Sharp Edge Inspections | Final Sharp Edge will occur during final PLB walk down | VITT | 06/30/05 | Low |

# Alternate/Dissenting Opinions

- **Alternate/Dissenting opinions were actively solicited from the EVA community as part of the STS-114/LF1 and EVA CoFR process**
  - EVA community consensus was reached concerning readiness for STS-114/LF1 operations and no dissenting opinions were identified

# STS-114/LF1 FRR

- **There are two EVA Exceptions for STS-114 / LF1**
  - One exception is being taken for open certification of EVA tools and crew aids (k)
  - One exception is being taken for open Hazard Reports for EVA tools and crew aids (l)
- **Pending closure of open work, the EVA Office is ready to proceed with the launch of STS-114 / LF1**
- **All STS-114 / LF1 open work will be closed or dispositioned by FRR or L-2 MMT**

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**Stephen C. Doering**
**Manager, EVA Office**

# ISS EMU Coolant Loop Recovery

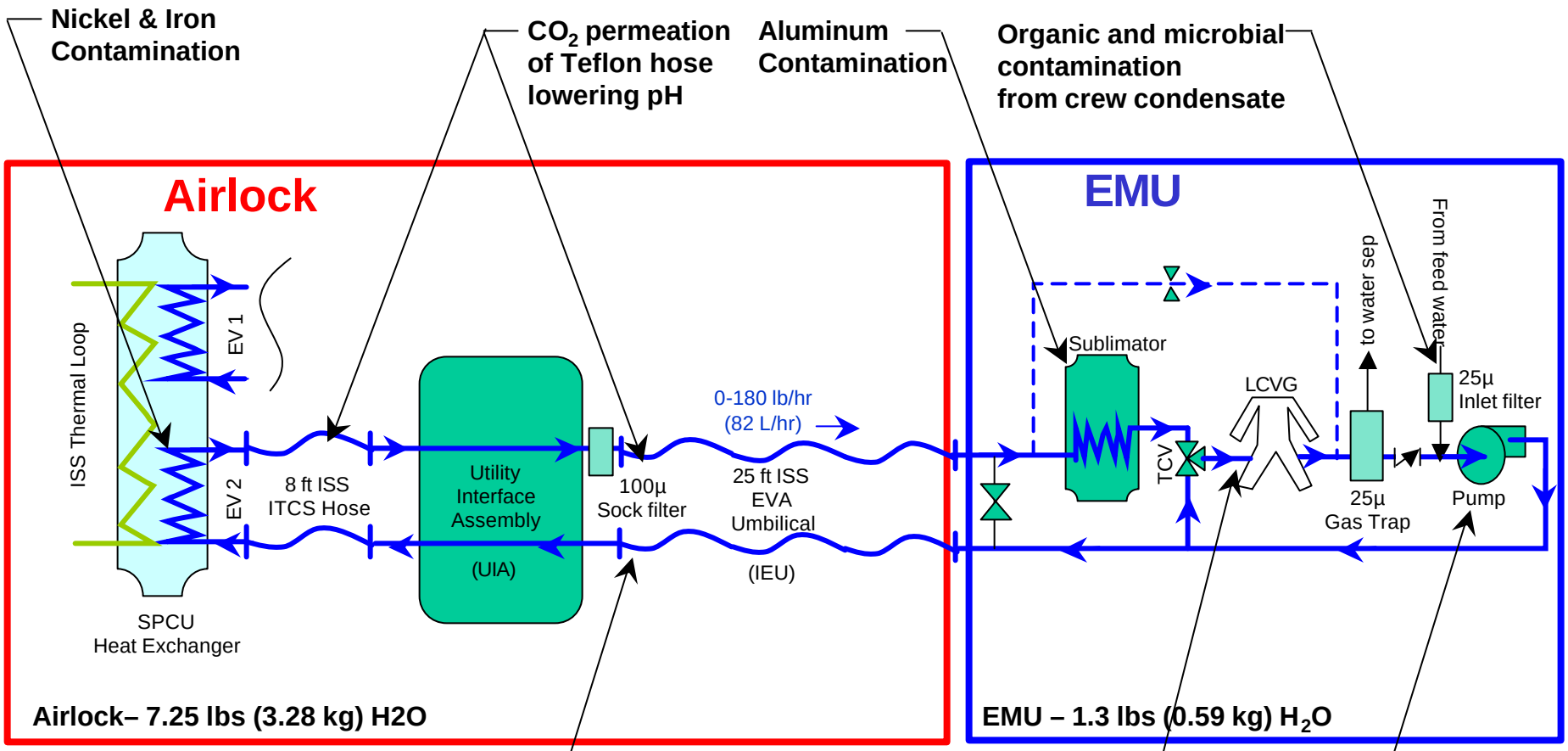
John Lewis, EMU Water Team Lead
NASA-JSC/EC6

Raul A. Blanco, EMU SSM
NASA-JSC/EC5

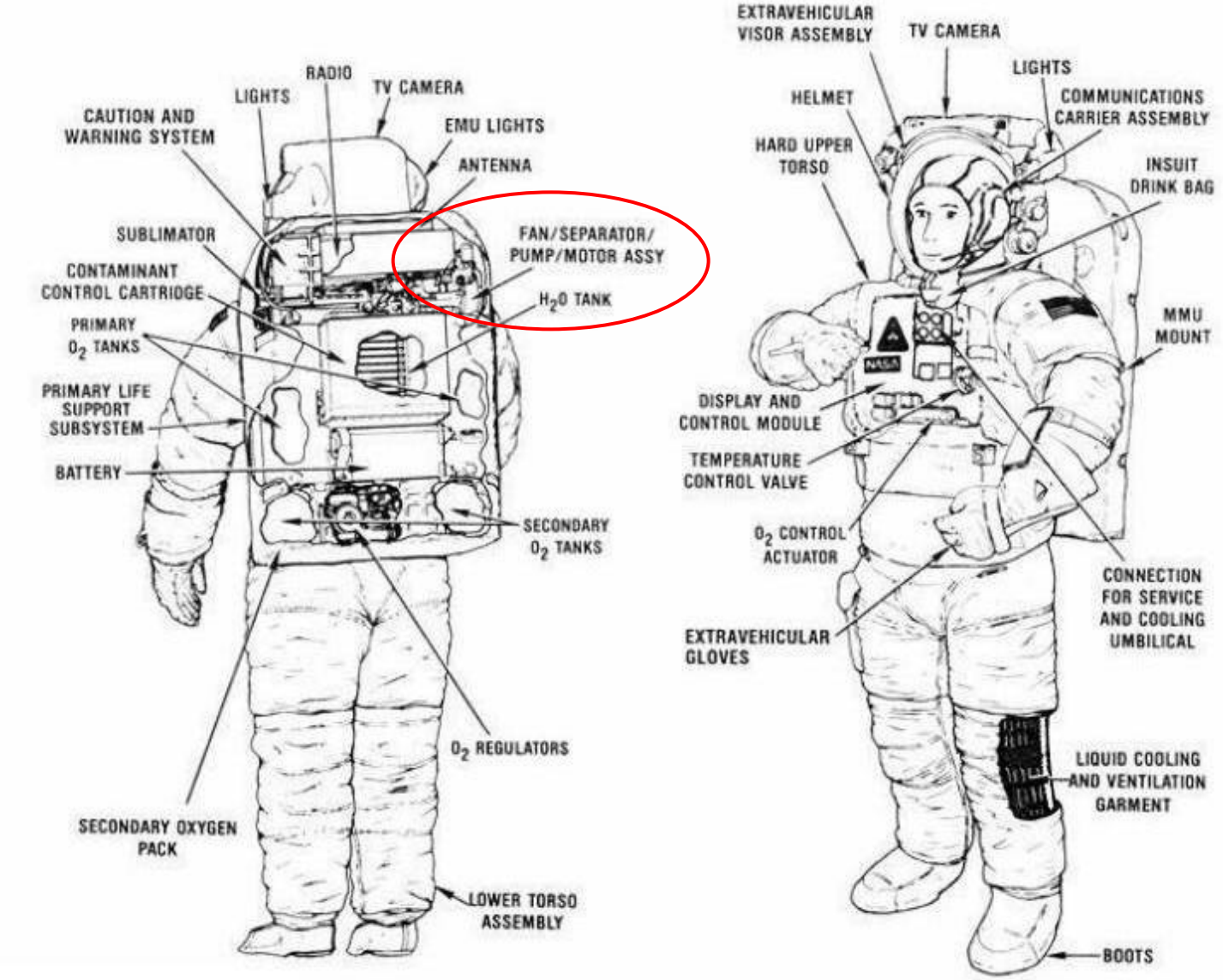
# Issues

- EMU failures on orbit
  - Two of three units onboard ISS have suffered coolant pump failures
- Significant Other Findings
  - SPCU Heat Exchanger was found to have corrosion problems that contributed to the EMU failures and also caused structural concerns
  - Pump rotors were found to have lengthened

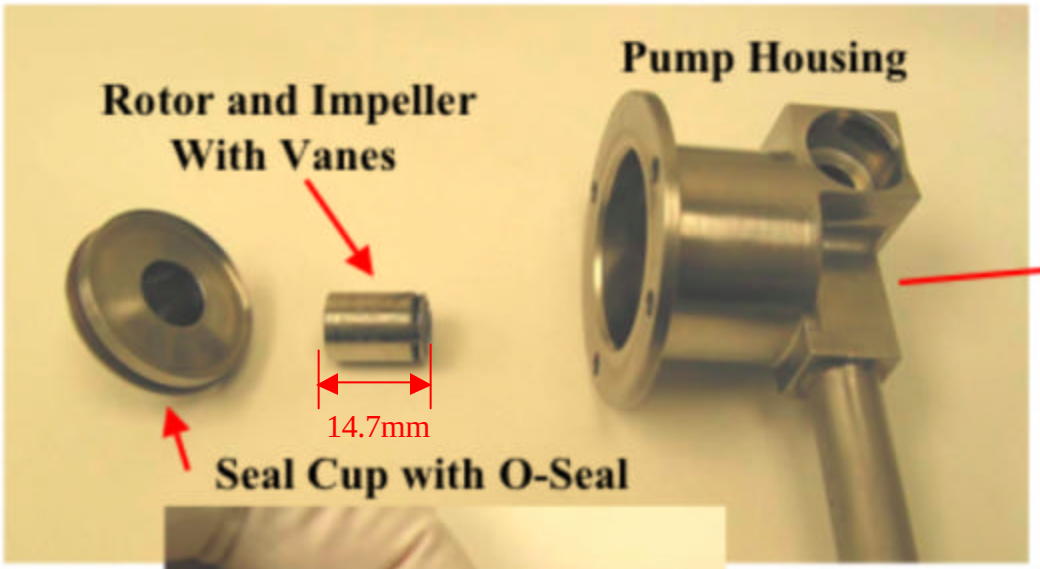
# Airlock/EMU coolant schematic

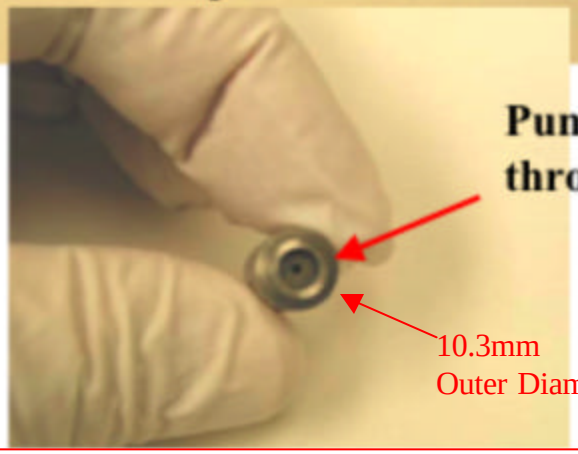


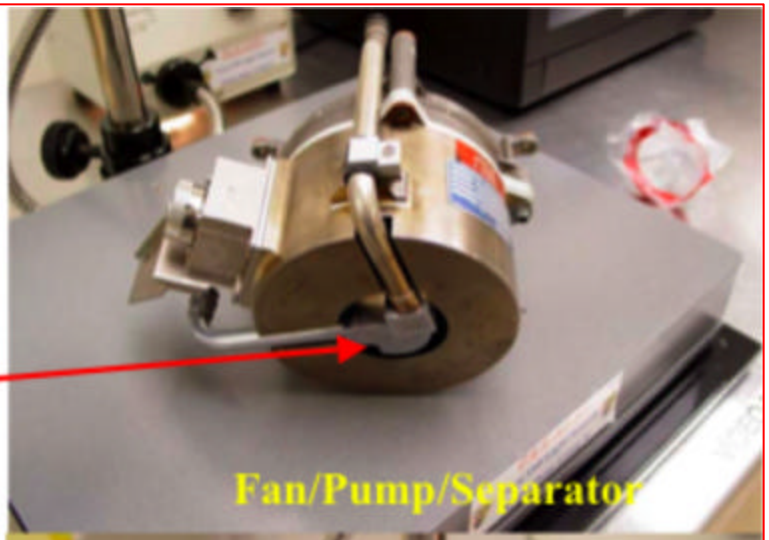
# Primary Life Support Sub-system (PLSS)

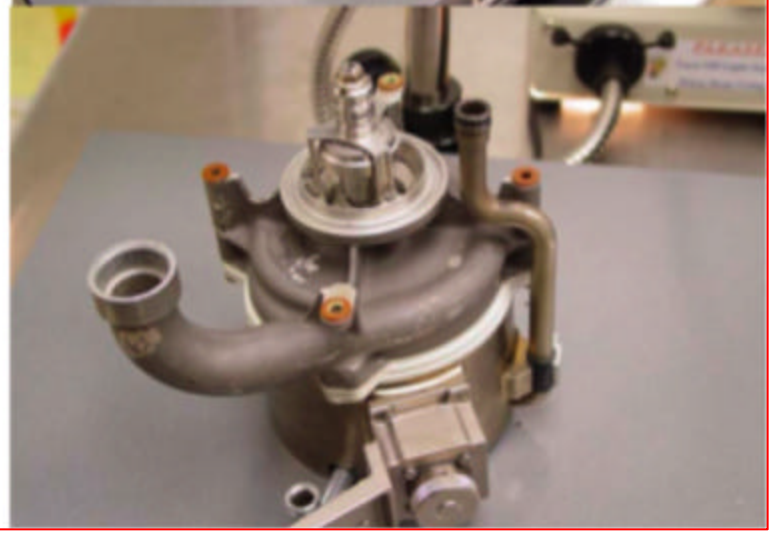


# Fan-Pump-Separator (F/P/S, Item-123)



# Root Cause

- EMU - Seizure of EMU coolant pump rotors
  1. Iron oxide - Source was the SPCU Hx
  2. Nickel Salts - Source was the SPCU Hx
  3. Biomass - Source is manned use and no post use ISS maintenance
- SPCU Heat Exchanger
  4. Corrosion - Single braze processing and unexpectedly low water pH
- Pump Rotor Lengthening
  5. Surface Preparation - Unstable process and lack of lifetime dimensional tracking

# EMU - Seizure of EMU rotors

Nickel and biomass fouled
Rotor was ‘gritty’ as it was rotated in cup

Iron oxide, Nickel and biomass fouled
Rotor was rotational ‘stuck’ in cup

Ground

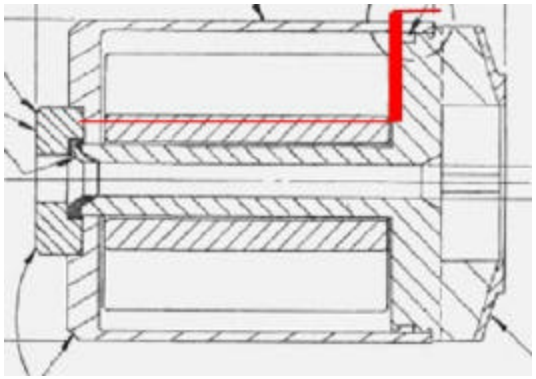
3013

3005

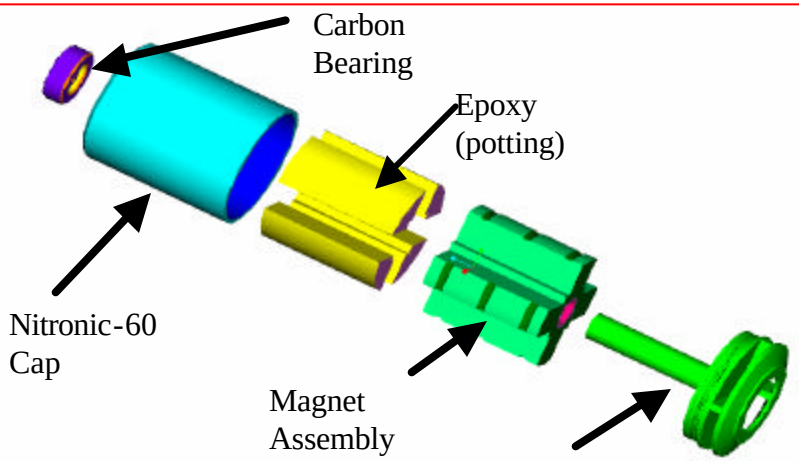
# SPCU Heat Exchanger -Corrosion

- SPCU Hx Rust
  - SPCU was planned to be changed out in 9/05 due to predicted limited life from single braze
  - Qualification SPCU produced rust from exposure to low pH water which was verified by a second test
  - Flight Spare double brazed SPCU showed no sign of rust from exposure to low pH water
  - Flight Spare SPCU manifested on 17P and successfully replaced during stage

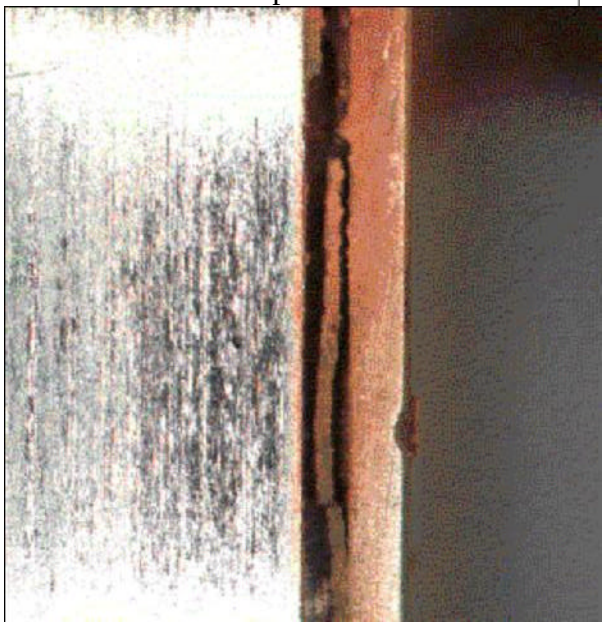
# Pump Rotor Lengthening



Rotor Assembly




- Bond line between impeller assembly and magnet/cap sub-assembly separated (red-line)



3005 Impeller Cap Debond

# Corrective Action

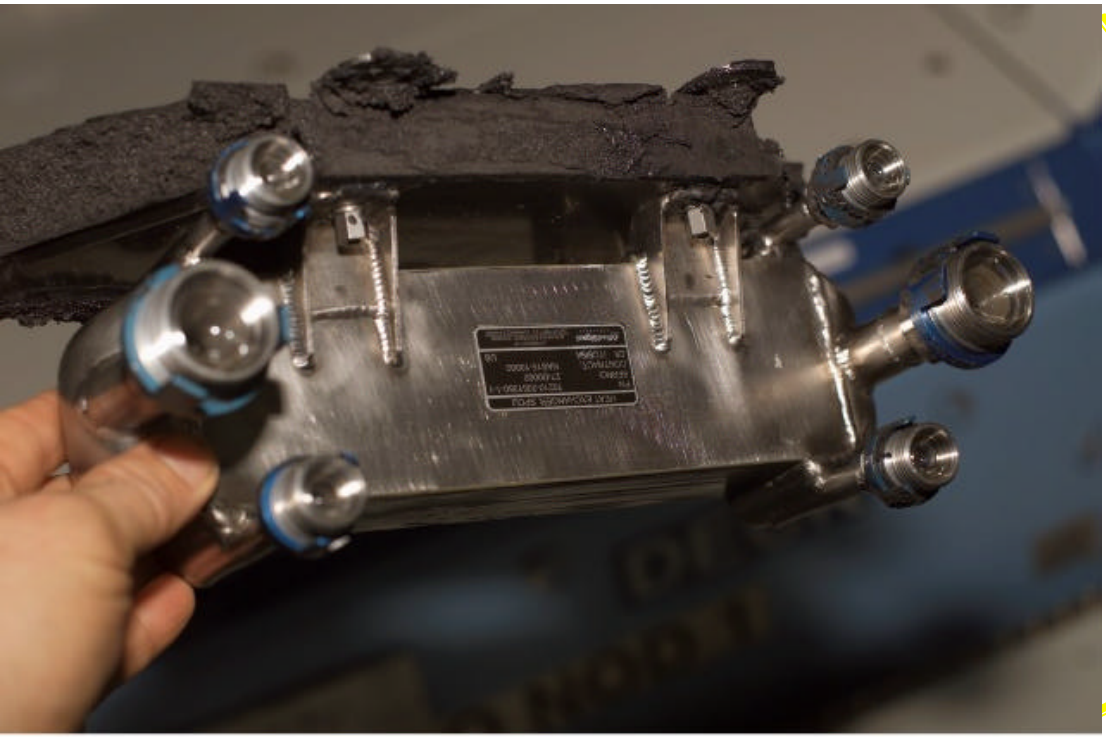
- EMU
  1. Iron oxide
     - Source was removed by replacing the SPCU Heat Exchanger on 17P
  2. Nickel Salts
     - Exposure to the EMU from the Hx corrosion products will be controlled by ionic contaminant removal and particulate removal with the use of ALCLR (Air Lock Coolant Loop Recovery) hardware which is manifested for STS-114
  3. Biomass
     - Biological growth in the coolant loop will be controlled by organic removal, particulate removal, and biocidal iodine addition with the use of ALCLR hardware

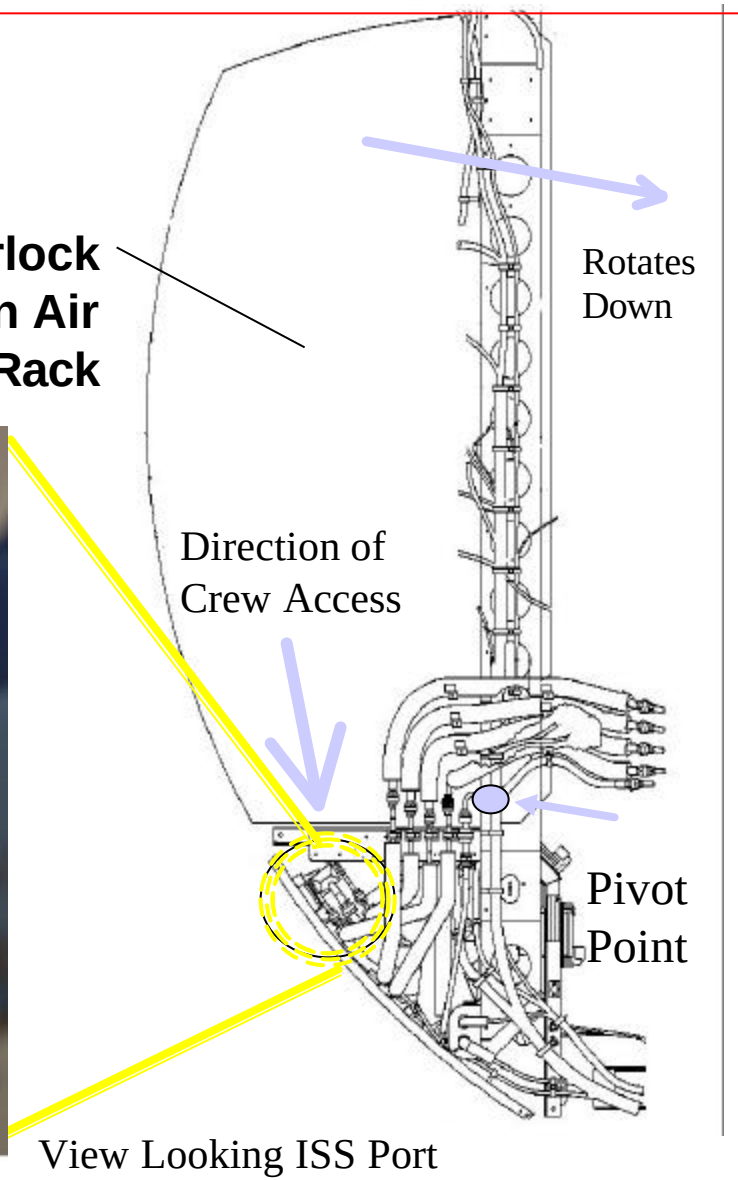
- SPCU Heat Exchanger
  4. Corrosion
     - The new Hx replaced on 17P is double brazed and is predicted to have a 10 to 15 year life.

- Pump Rotor Lengthening
  5. Surface Preparation
     - All rotors have been screened and inadequately bonded rotors have been removed from the fleet
     - All new rotors are built with more robust processes and their length and bonds are tracked

# SPCU Hx Changeout

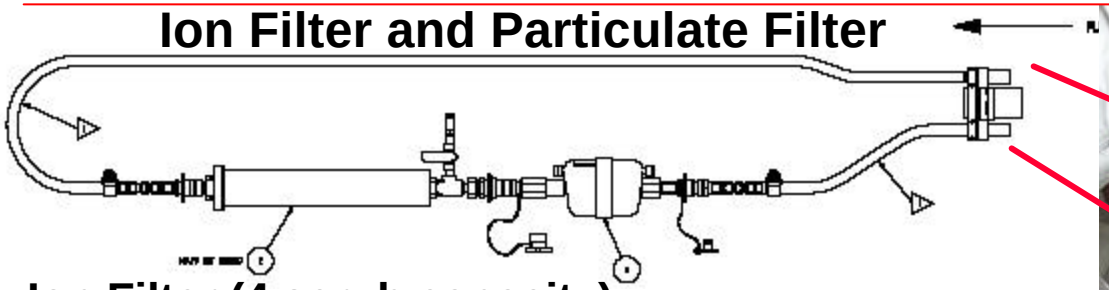
- Flight Spare double brazed SPCU showed no sign of rust from exposure to low pH water
- Flight Spare SPCU manifested on 17P and successfully replaced during stage Successfully performed R&R



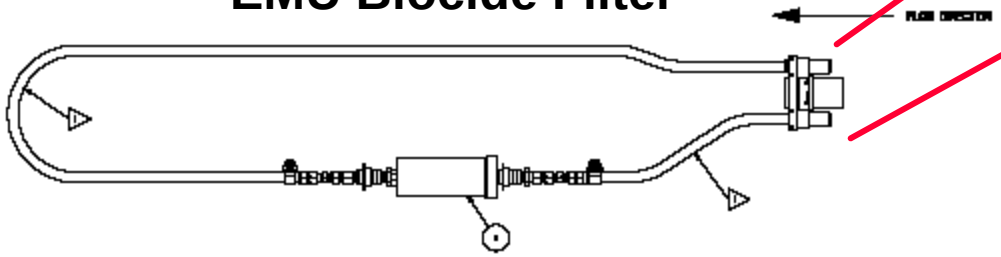
# Airlock Coolant Loop Recovery Unit

## Ion Filter and Particulate Filter

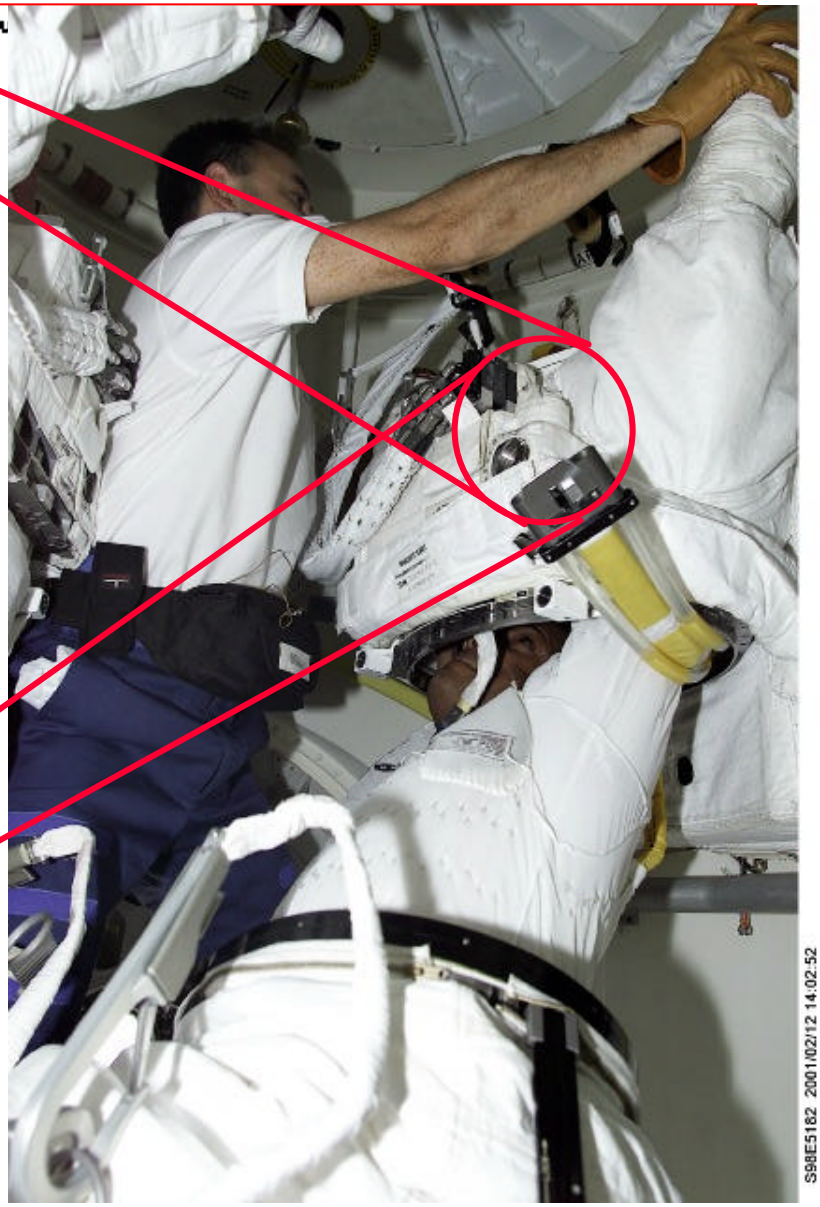


- **Ion Filter (4 scrub capacity)**
  - **Activated Carbon to remove organic contaminants.**
  - **Ion exchange resin to remove ionic contaminants**
- **Particulate filter (1 scrub capacity)**
  - **Polyprop filter to remove particulate contaminants**

## EMU Biocide Filter



- **Biocide Filter (1 scrub capacity)**
  - **Ion exchange resin to iodinate water**



# Summary

- ISS EMU and Airlock Failures
  - Two of thee units onboard ISS have suffered coolant pump failures
    - Evidence from orbit has indicated iron oxide, nickel salts, and biomass caused a seizure of EMU coolant pump rotor
  - A significant other finding was the growth of the pump rotor
- Corrective Actions in Place
  - Contaminated ISS Airlock hardware has been replaced with an upgraded unit and recently filtered and flushed
  - Coolant loop conditioning hardware manifested on STS-114
  - Operational plan in place to control contaminants
  - Pump rotor length is monitored and a design solution is in place
- ISS Airlock and STS-114 EMUs are ready for EVA use

# STS-114/LF1 FRR

## Back-up Charts

# EVA Fit Checks

- **Tool-to-tool Fit Checks**
  - Current Total Complete (118 of 128) - 92%
    - 5/5 Payload Bay = 100%
    - 43/49 TSA = 88%
    - 46/50 Middeck = 92%
    - 24/24 MPLM = 100%
  - 10 fit checks will remain open for flight
    - Hardware delivery scheduled after interfacing hardware was installed
    - Dispositioned by the EVA CCB as no impact to STS-114
    - All open fit checks are low-risk, common interfaces which support contingency TPS inspection/repair and workarounds exist should tools not fit together properly
- **Tool-to-Interface Fit Checks**
  - 100% complete
- **Sharp Edge Inspections**
  - Final Sharp Edge Inspection will be completed at final Payload Bay Walkdown – June 30, 2005

# Back-up Charts

- **EVA Tool-to-Tool fit check matrix**
  - Open fit checks for flight
    - Passive WIF Adapter to PFR Attachment Device (PAD)
      - Reason
        - » Interfacing hardware was shipped to KSC before Passive WIF adapter was delivered
      - Low Risk
        - » WIF Adapters were interfaced with a PFR socket as part of PDA. The PAD has been successfully fit checked to numerous PFR probes.
        - » No planned use for this hardware combination
        - » Alternatives exist should this hardware combination be required and not fit together properly

# Back-up Charts

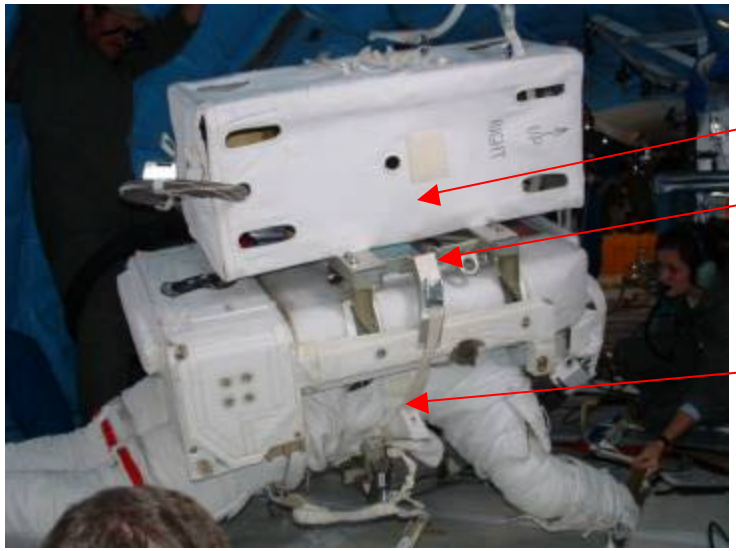
- **EVA Tool-to-Tool fit check matrix cont.**
  - Open fit checks for flight cont.
    - TRK Stowage Bag to:
      - EVA Trash Bag
      - Compound Needle Nose Pliers Tool Caddy
      - CIPAA Gun Holster
    - MMWS Gimbal Assy to:
      - CIPPA Gun Holster
  - Reason
    - Hardware delivery scheduled after interfacing hardware installation
  - Low Risk
    - Interfaces that have not been fit checked are bayonet probes which are common and have a good history of mating properly
    - Tools support contingency TPS repair operations and workarounds exist should tools not fit properly

# Back-up Charts

- **Other open hardware issues affecting EVA**
  - Compound Specific Analyzer -O2 (CSA-O2) certification remains open – Certification ECD July 1, 2005
    - CSA-O2 provides $O_2$ monitoring capability at 10.2 psi
      - It is required, in addition to the Mass Constituent Analyzer (MCA), to perform EVA exercise pre-breathe protocol for ISS-based EVAs
    - Impact of hardware unavailability
      - No impact to nominal LF1 mission
      - Without the CSA-O2, a TPS repair EVA conducted in the Orbiter Repair Maneuver (ORM) configuration would violate Flight Rules
        - Repair in ORM configuration requires use of the ISS Airlock
        - 4-hour in-suit pre-breathe breaks TPS repair timelines

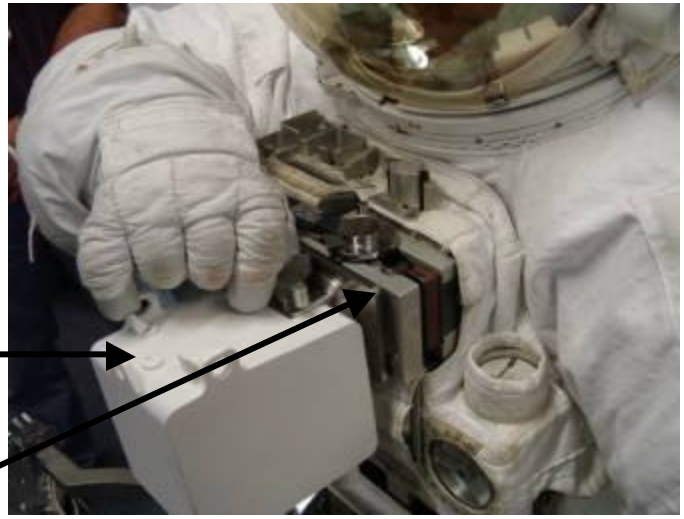
# Back-up Charts

- **EMU New Hardware / Certification Overview**
  - Tile Repair Backpack frame (TRBF) EVA-00092
    - Attaches Cure-In-Place Ablator Applicator (CIPAA) backpack to back of PLSS
    - Donned during prebreathe after SAFER donning for contingency ops. only.
    - CR EVA-000161 ECD 4/15/05 Spec revision and Limited Life Items List update
    - CR EVA-00155 Incorporated frame into FEMU-R-001, FEMU-R-003, FEMU-R-004 - Complete



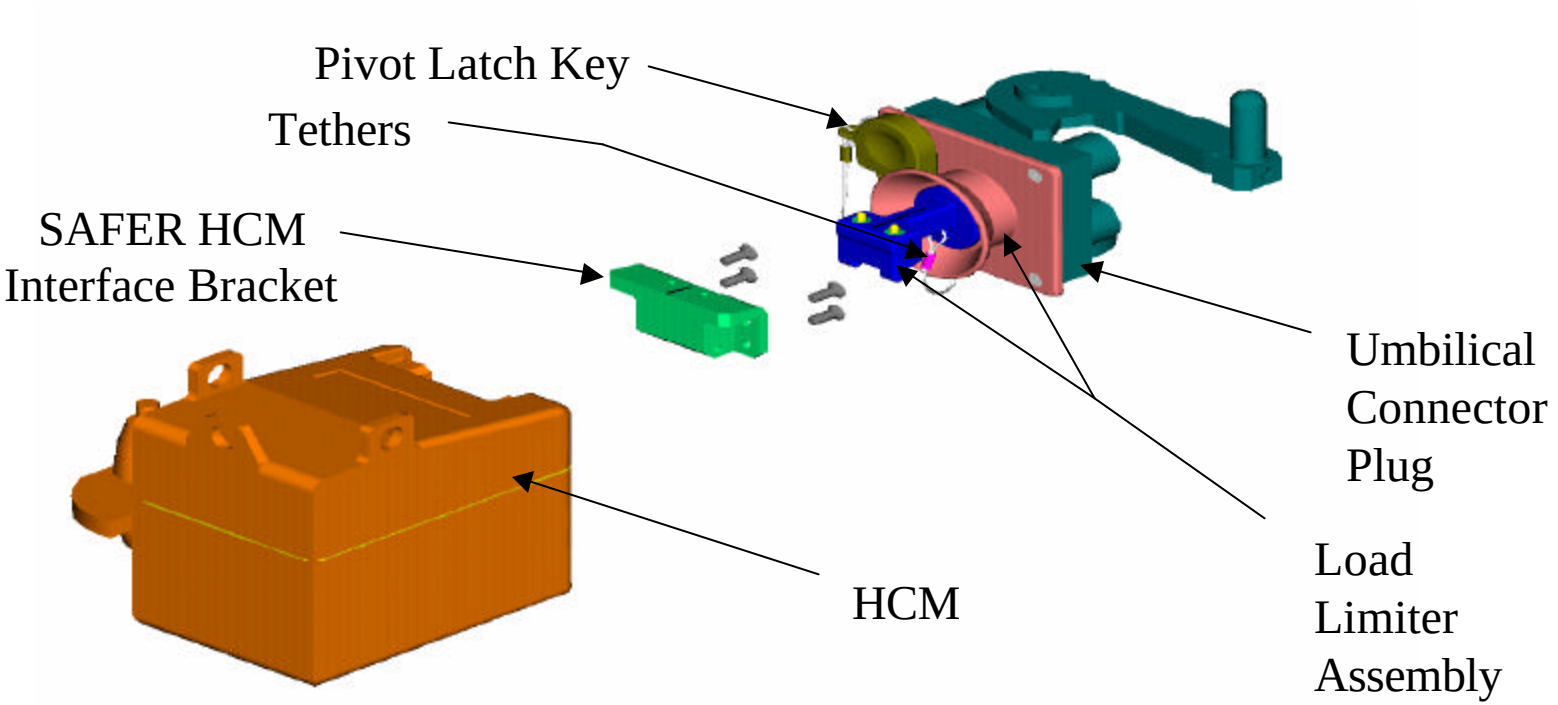
# Back-up Charts

- **EMU New Hardware / Certification Overview (cont)**
  - SAFER Hand Controller Module Hard Mount H7409
    - Currently the Safer Hand Controller Module is held with two hands for operation
    - Single-handed operation is required for Thermal Protection System (TPS) inspection
    - Safer Hand Controller Module Hard Mount provides single handed operation during TPS inspection from shuttle
    - Fit check to DCM requirement to be completed prior to flight
      - CR EVA-000160 ECD 4/15/05 - Spec revision and Limited Life Items List update
      - CR EVA-00155 Incorporated hardware into FEMU-R-001, FEMU-R-003, FEMU-R-004 - Complete



# Back-up Charts

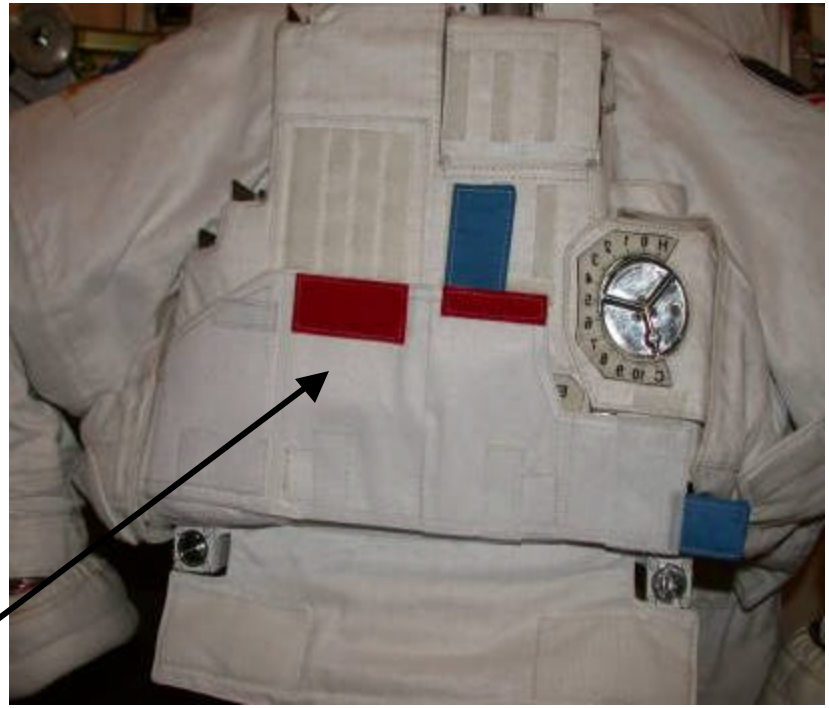
- **EMU New Hardware / Certification Overview (cont):**
  - SAFER Hand Controller Module Hard Mount (cont)
    - Hand controller mounted to DCM with a modified SCU connector plug through a load limiter to protect DCM from HCM impact
    - Load limiter concept utilizes a magnet with bracket detents



# Back-up Charts

- **EMU New Hardware / Certification Overview (cont)**
  - $O_2$ Actuator Switch Cover certification and development
    - Cover prevents ablator material from jamming EMU O2 Actuator
    - If O2 Actuator stuck EVA position during airlock repress, SOP will flow depleting high pressure O2.
    - 2 being launched installed on EMUs for DTO EVA#1 and will be left on-orbit.

EVA-00090 Cert. Complete

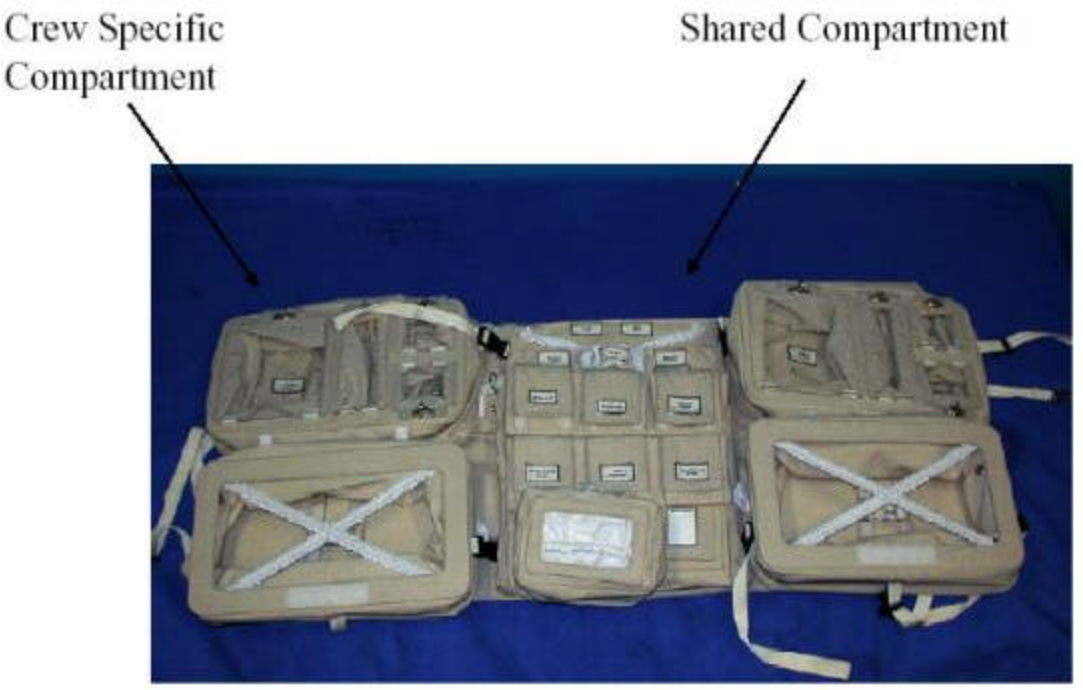


## •EMU New Hardware / Certification Overview (cont)

– EMU Equipment Bag

H7303R1 Completed

- Composed of 1 generic section that includes items that are not unique to CM such as SCOF, MWC Jumper Loop Cover, Prybar, etc.
- 2 detachable crew specific sections that contains items such as Phase VI gloves (not flown in bag), wristlets, eye glasses, CCA Cap, etc.
- Replaces the current Airlock Stowage Bag to support shuttle/station requirements.




Bag designed to attach to airlock and assist EMU donning

# Back-up Charts

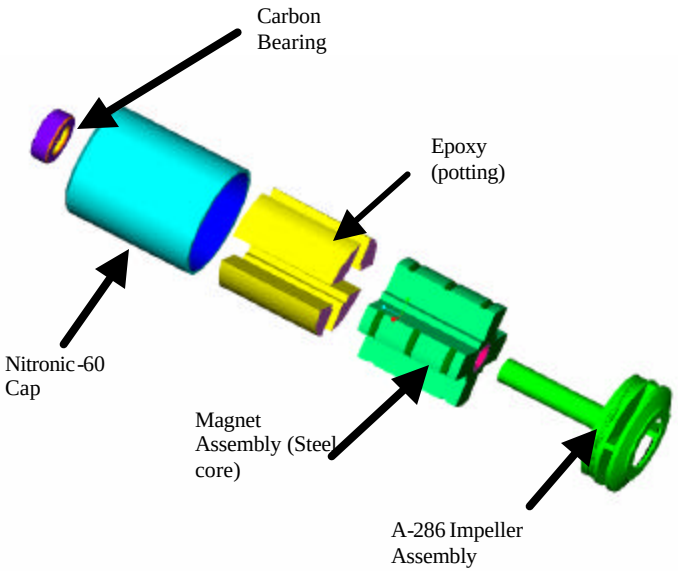
- **EMU New Hardware / Certification Overview (cont)**
  - Updated the EMU servicing kit (-304): EVA-00089 Cert Complete
    - De-certifies –302 config. (disposable electrodes)
    - Deleted alcohol wipes due to ISS on-orbit alcohol ban
    - Certify alcohol replacement – Astro Gel shaving cream, Ivory soap, and Dial Soap along with Gillette Twin Blade Razor to prepare crewmember skin for OBS electrode attachment.
    - V0004 incorporated the following updates to EMU servicing kit (-303) added:
      - Moisture Barrier Earphone Diaphragms (MBEDs)
      - EMU Softgoods barcode added to ESK
      - Bio-med Cable and Comm. Pigtail with Lemo connectors for new configuration EEH

# Back-up Charts

- **EMU New Hardware / Certification Overview (cont)**

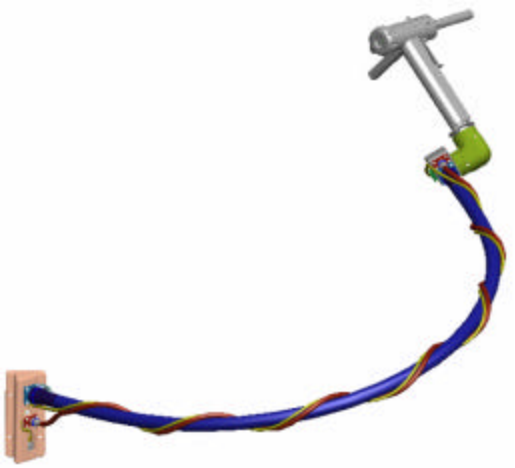
  – Replacement F/P/S rotor epoxy certification for STS-114 EVA-00093 Complete

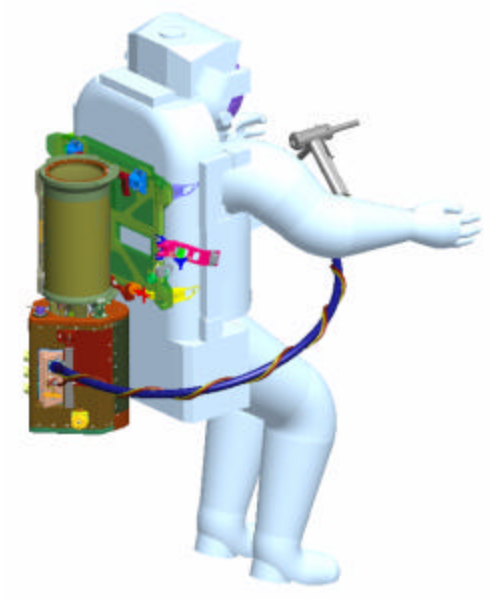
    - Adhesive system (Epon 815 and catalyst U) material previously used in no longer available.
    - Implements rotor with new Hysol EA9360 A/B for STS-114 only
      – Carbon bearing to cap
      – Magnet assembly potting
      – Impeller assembly to cap assembly
    - Applicable to SEMU 3017 (up/down unit) only.



# Back-up Charts

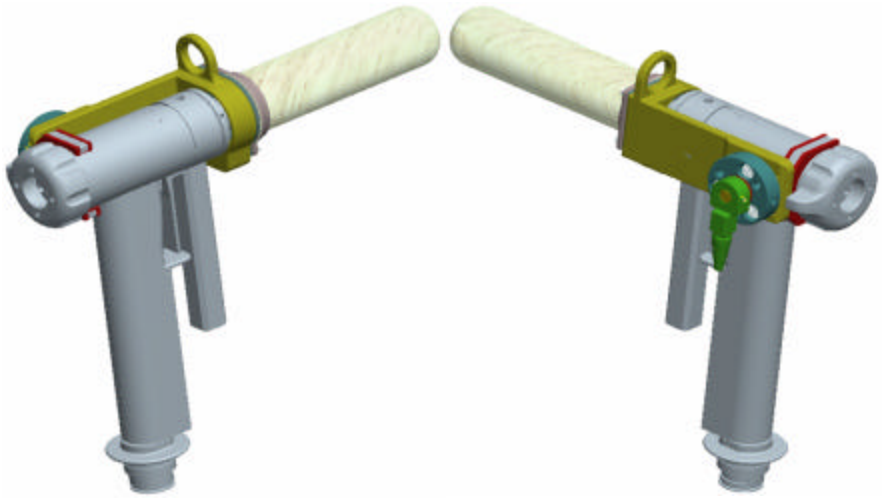
- **CIPAA MAIN UNIT ASSEMBLY, SED33116521-302**
  - Ablator parts A and B stored in Inconel and 316 stainless steel reservoirs.
  - Gaseous Nitrogen (GN2 ) is used to generate ~300 - 400 psi in the ablator
- **HOSE MIXER GUN (HMG) ORU ASSEMBLY SED33117960-301**
  - A pair of 5-foot hoses attach as an IVA-ORU at a manifold on the CIPAA main unit
  - 8 static mixer elements are used, 2 in the mix block, 6 in the gun handle
  - The gun is a valve for the ablator, employing GN2 to reduce the force needed to operate the valve





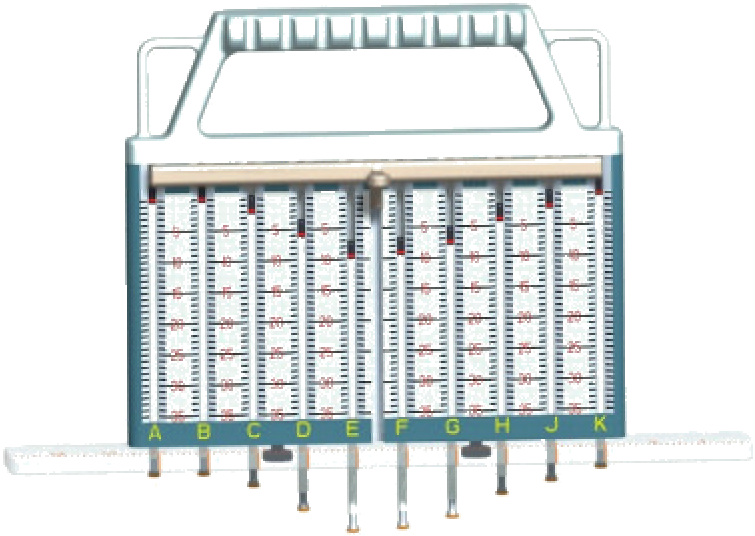
# Back-up Charts

- **HOLSTER (GUN HOLSTER), SED33116759-301**
  - Provide temp stow location with clockable bayonet fitting for gun assembly.
- **CIPAA CLEANING KIT, SED33116670-301**
  - Clean uncured ablator components “A” and “B” from Main Unit following de-mate of HMG



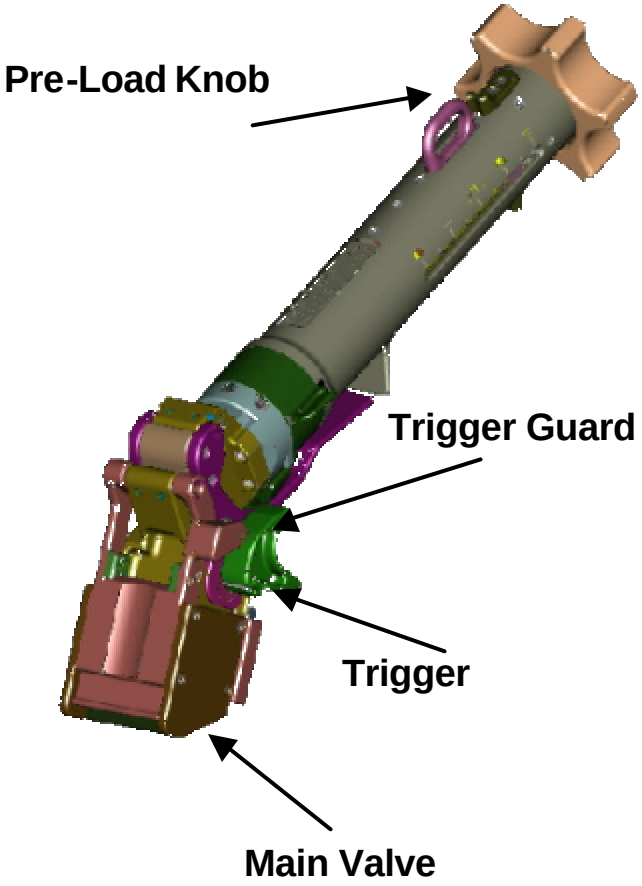
# Back-up Charts

- **CONTOUR GAUGE, MECHANICAL, SED33117613-301**
  - Provides profile measurements from 0” to 4” depths for damage assessment and/or underfill verification
  - Display provides both graphical and numeric data
- **DUROMETER ASSEMBLY, SHORE A, SED33116957-301**
  - The Type A Durometer Assembly will be used to verify that the CIPA material used during an on-orbit tile repair has properly cured.
- **DUROMETER TEST KIT, SED33117950-301**
  - Ensures on orbit functionality of Shore A Durometer.



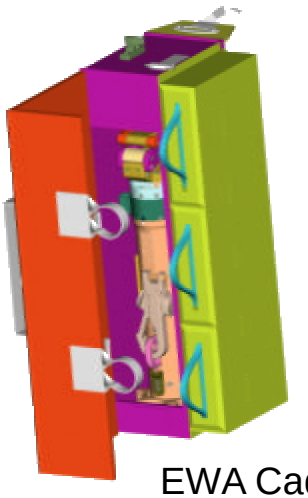

# Back-up Charts

- **EMITTANCE WASH APPLICATOR (EWA), SED33116809-302**
  - Dispenses RTV 511/Silicon Carbide (SiC) mixture Pre-load mechanism to dispense Emittance Wash



# Back-up Charts

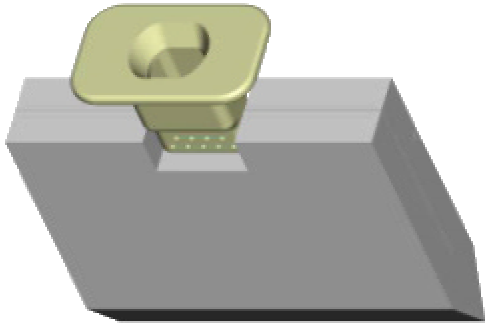
- **EMITTANCE WASH CADDY, SED33116933-301**
  - Provides stowage for the following EWA and associated hardware
- **REMOVABLE BRUSH HANDLE ASSEMBLY, SED33116385-301**
  - Removable handle provides a common handle for use with all Foam Brushes and Gel Brushes
- **1 IN. FOAM BRUSH ASSEMBLY, SED33117199-701, 3 IN. FOAM BRUSH ASSEMBLY, SED33117199-703**
  - The Foam Brushes are used to smooth, flatten and level the surface of the repair during application of CIPA.



EWA Caddy

Handle

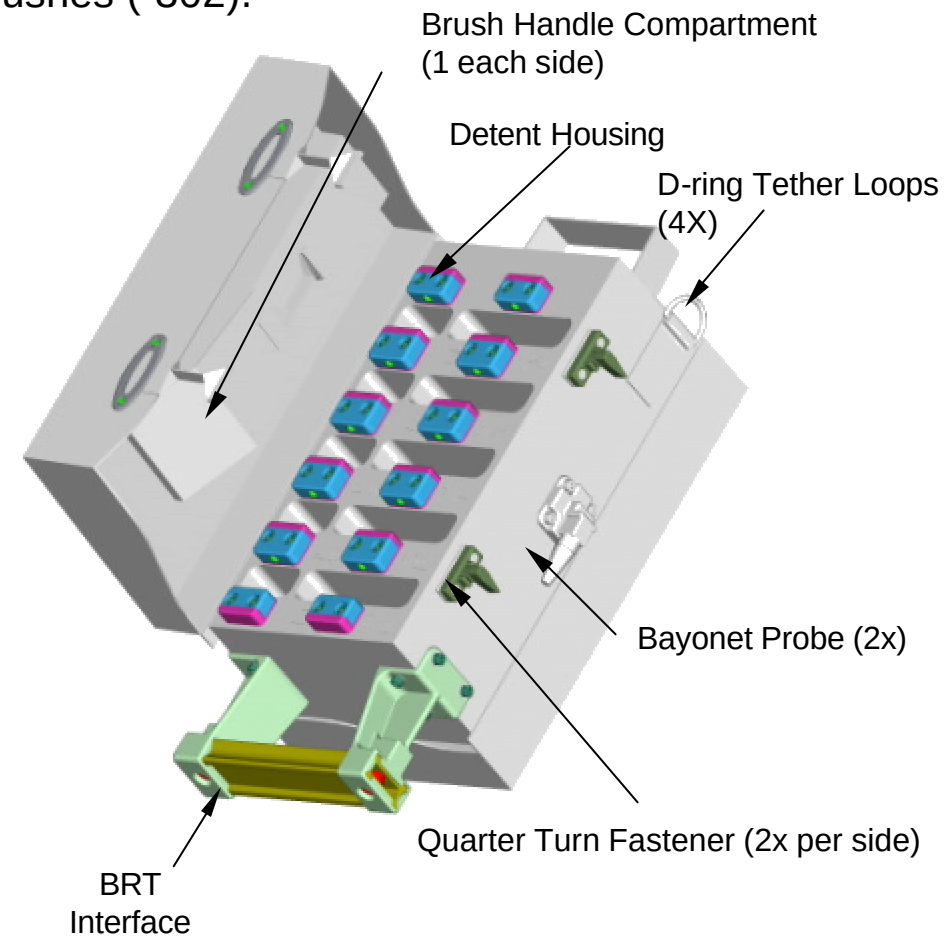
3” Brush



1” Brush

# Back-up Charts

- **SILICONE GEL BRUSH CADDY, SED33116360-301, -302**
  - Provides stowage for foam and gel brush hardware
  - Gel Brushes only (-301)
  - Foam and Gel Brushes (-302).



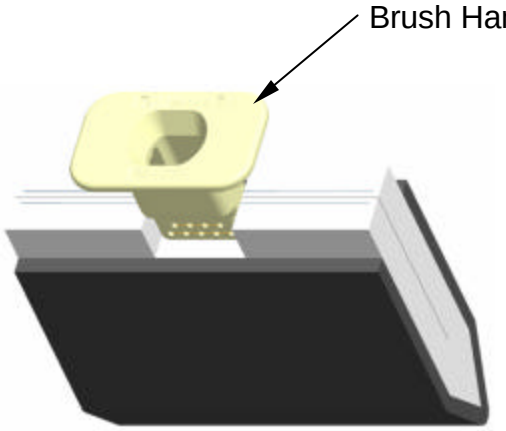
# Back-up Charts

- **1 IN. SILICONE GEL BRUSH, SED33116394-701**
- **3 IN. SILICONE GEL BRUSH, SED33116394-703**
- **PENCIL TIP GEL BRUSH, SED33116394-705**
  - Provides tack for tile dust removal/clean-up

## Gel Brushes

Pencil-Tip

1”




3”

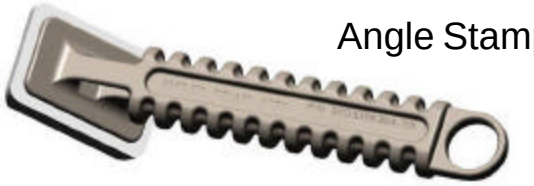
# Back-up Charts

- **CIPA DISCARD CONTAINER ASSY, SED33117130-301**
  - The CIPA Discard Container provides features for the removal and containment of CIPA collected by the Scraper.
- **EVA WIPE, SED33116397-703**
  - EVA Wipes can be used to clean items contaminated with CIPA, Emittance Wash, or NOAX to a “usable” condition.

# Back-up Charts

- **3 IN. SCRAPER, SED33117195-301**
  - The Scraper is designed to remove uncured CIPA material from the tile surfaces surrounding a repair.
- **ANGLE STAMP, SED33116364-701 (Qty: 4)**
  - The Angled Stamp is used to periodically smooth, flatten and level the surface of the repair during application of CIPA.
- **FLAT STAMP, SED33116370-701 (Qty: 1)**
  - The Flat Stamp is used to smooth, flatten, and level the surface of the repair during application of CIPA.
- **MWS TOOL STOWAGE CADDY (TSC), GD2051000-301 (Qty: 2)**
  - Tool Stowage Caddy is capable of retaining two tile and RCC Repair Hand tools

3” Scraper



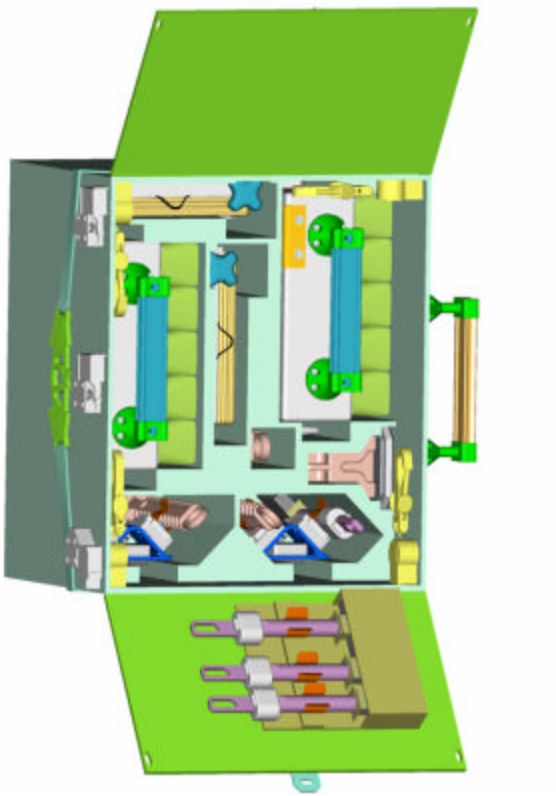
Angle Stamp

Flat Stamp

MWS TSC

# Back-up Charts

- **TILE REPAIR KIT (TRK) STOWAGE BAG, SED33117140-301**
  - Provides Launch/Landing and worksite stowage for the following tools tile repair hand tools:



# Back-up Charts

- **EVA Marker, SED33118188-301**
  - The RCC marker is used to mark positioning cues on the RCC for installation of the plug repair.
- **2” and 5” Crack Repair Material (CRM) Scrapers, SED33118187-301, -302**
  - The crack repair scrapers will shape and feather the CRM as needed
- **Ruler / Protuberance Gauge (RPG), SDD33118222-301**
  - Ruler provides a straight edge for marking the correct installation location of the plug repair.
  - The protuberance gauge ensures that the maximum protuberance of the plug is less than either 0.20” or 0.25”

EVA Marker

2” CRM Scraper

5” CRM Scraper

RPG

# Back-up Charts

- **Large and Small EVA Drill, SED33118888-301, -302**
  - The large drill will enlarge a 0.5” hole in RCC to a 1.1” diameter hole for insertion of the plug.
  - The small drill will enlarge coating damage in RCC to a 0.5” diameter hole
  - Requires no normal force to the RCC surface to enlarge the hole.
- **Plug Installation Tool, SED33118200-301**
  - Installation aid for plug repair.
  - Velcro pad for temporary plug attachment.
- **EVA Feeler Gauge, SED33118188-301, -302**
  - The feeler gauge will ensure that the maximum gap between the plug and RCC is safe for reentry.

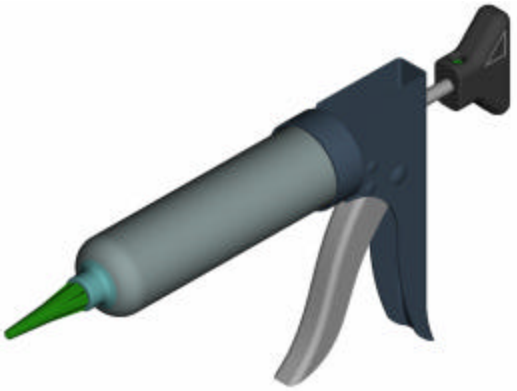
Gap Gauge

RCC Drills

Plug Installation Tool

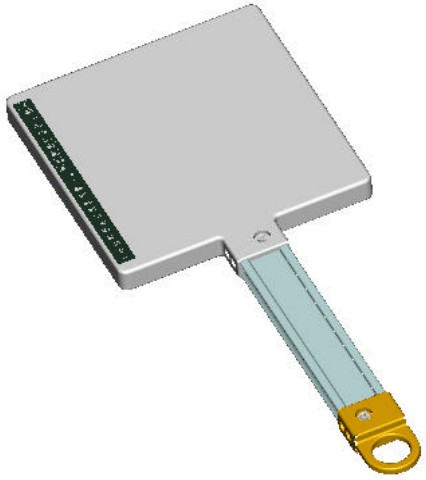
# Back-up Charts

- **Manual Crack Repair Gun**
  - The Manual Crack Repair Gun applies NOAX for the crack repair project
  - Also applies NOAX sealant for the plug repair when the edge gap is too large
- **EVA Thermal Sensor, SED33118700-301**
  - The EVA thermal sensor displays the temperature of RCC for correct application of crack repair material.



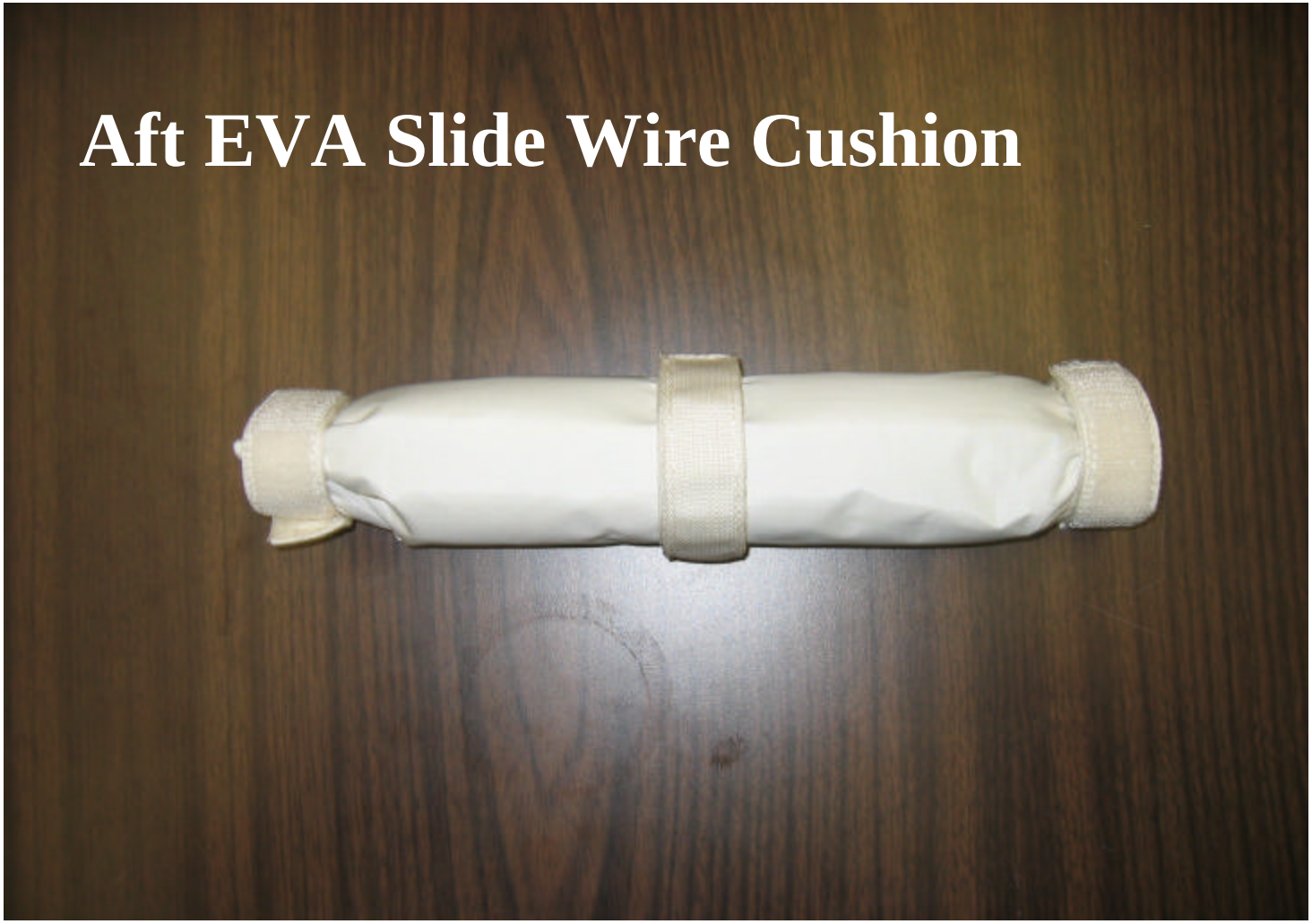
# Back-up Charts

- **Crack Repair Bag, SED33118750-301**
  - Provides insulted carrying case for Crack Repair Tools.
- **Crack Repair Palette, SED33118670-301**
  - Provided degassing surface for NOAX crack repair material.

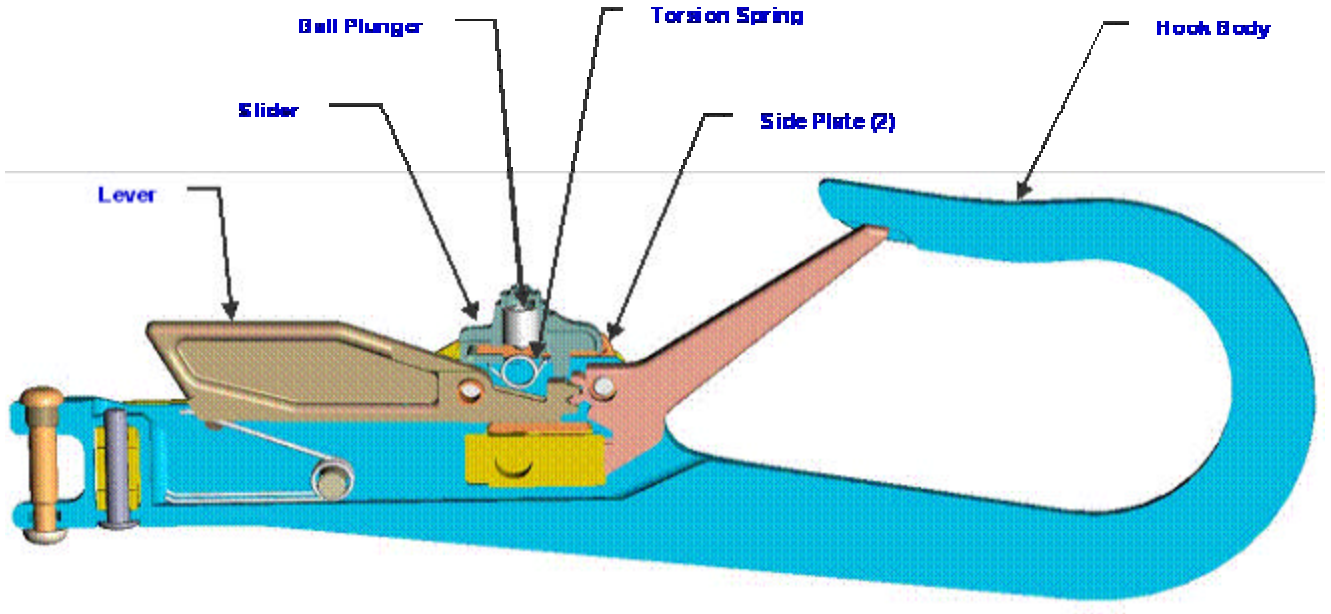


# Back-up Charts

## Aft EVA Slide Wire Cushion

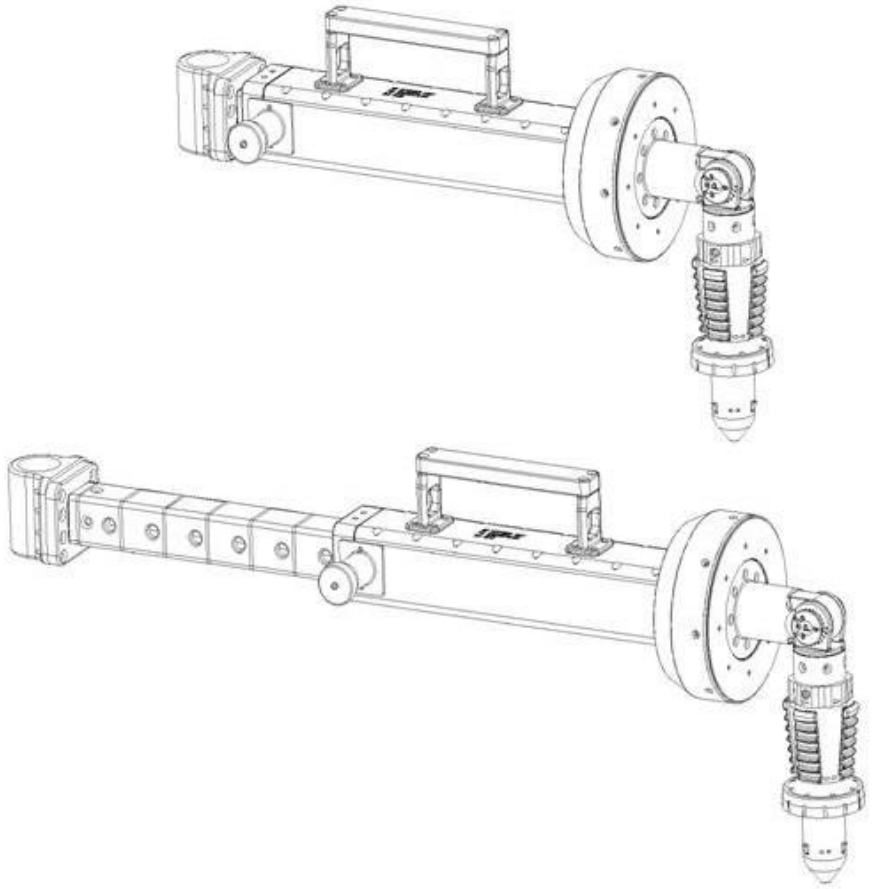


# Back-up Charts




## Locking Crew Hook

# Back-up Charts

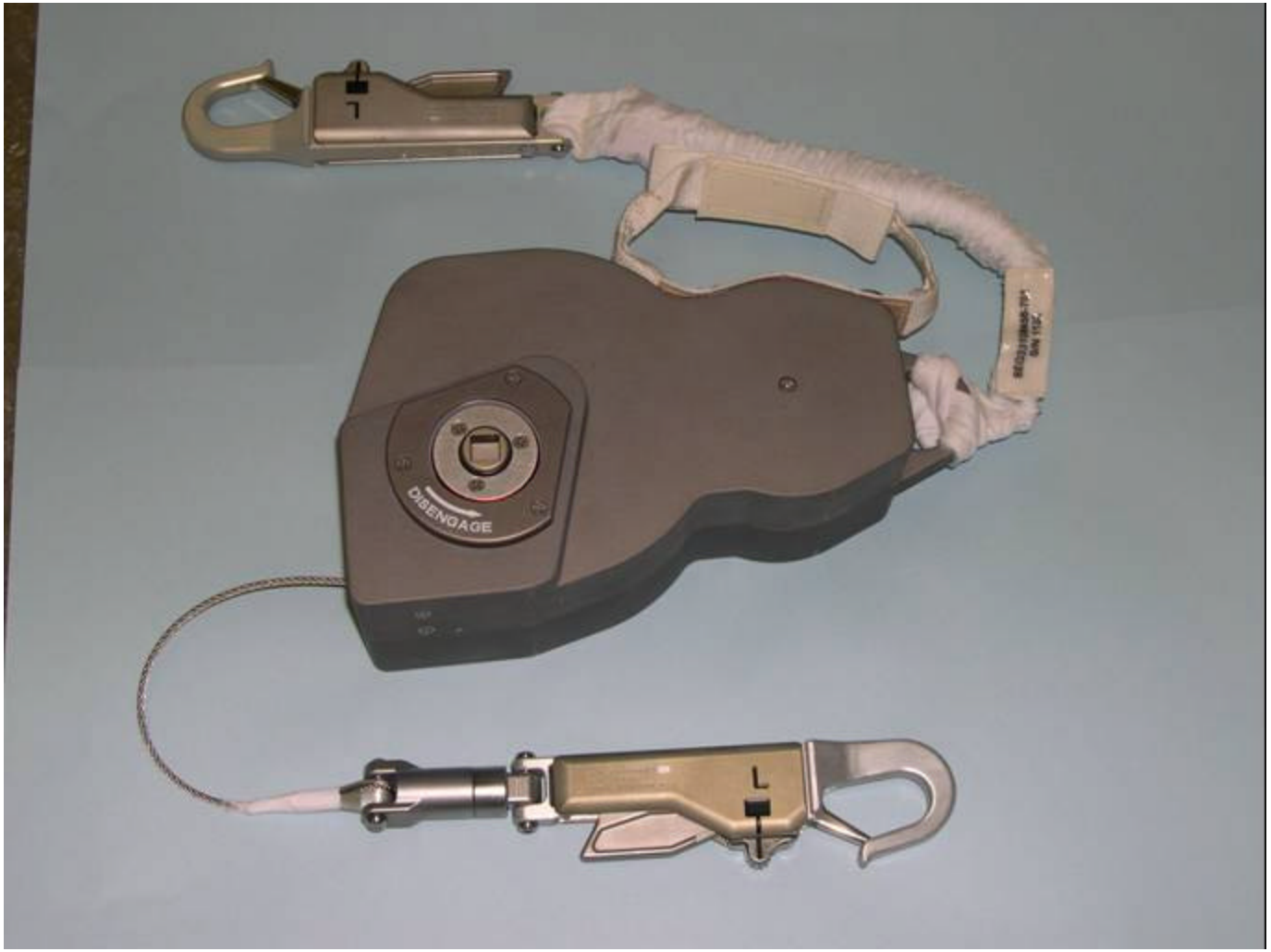


## WIF Extender

# Back-up Charts


Torque Analyzer Kit

# Back-up Charts




## 85FT Safety Tether

# Back-up Charts

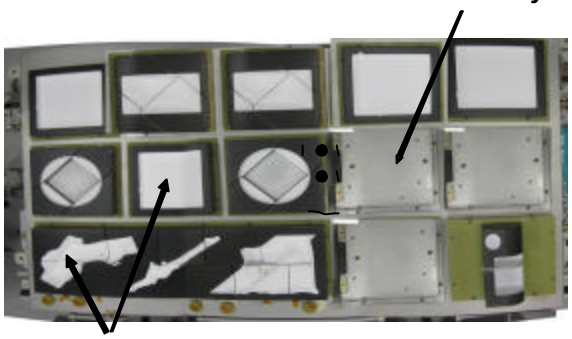
- **CONTAMINATION DETECTION KIT (CDK), SJD39136050-302**
  - Used to measure possible contamination immediately following an EVA
- **Hardware Status:**
  - Flight Drawings: complete
  - Hardware Fabrication: complete
  - Acceptance Testing: complete
  - Shipment: complete
- **Certification Status:**
  - CARD: released
  - Certification testing: complete
  - GCAR: 13 Apr (exception h)
- **Exception Codes:**
  - h/g. Flight hardware or software certification is complete
- **Summary of Risk (and Risk Factor): 1 (Low); RAESR awaiting sign-off; GCAR in signature loop (pending RAESR approval)**

# Back-up Charts

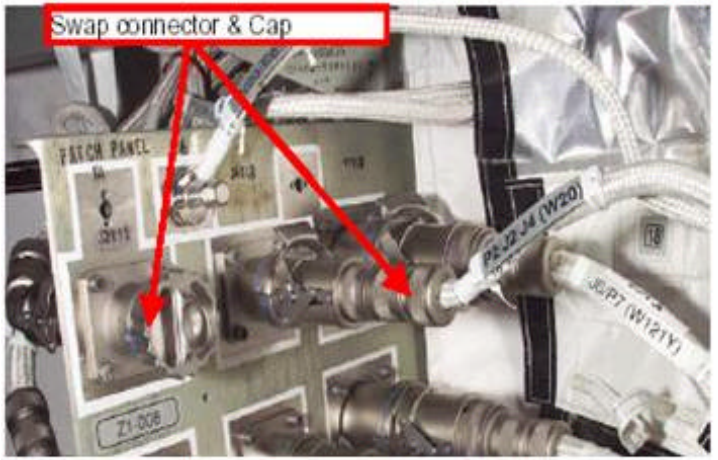
- **EVA DIGITAL CAMERA BRACKET**
  - Provides Mounting for EVA Digital Camera Assembly to MMWS swingarm.

# Back-up Charts

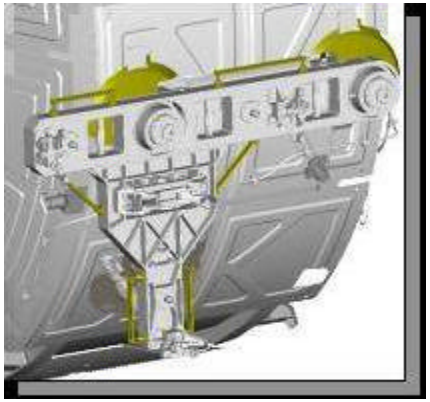
## DTO Box Lay-Out




EWA DTO




Z1 Patch Panel

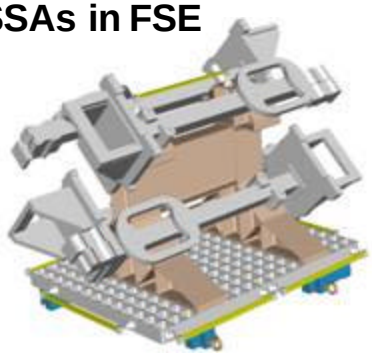


ESPAD Installation

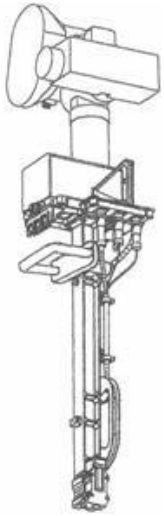
ESP-2 Primary Cable

# Back-up Charts

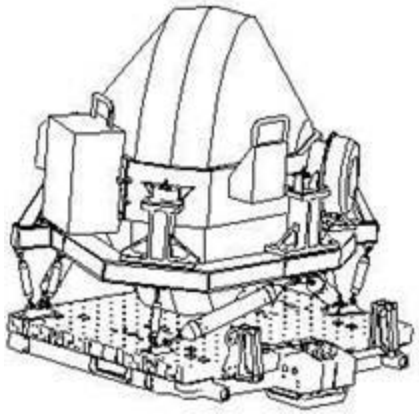
## VSSAs in FSE

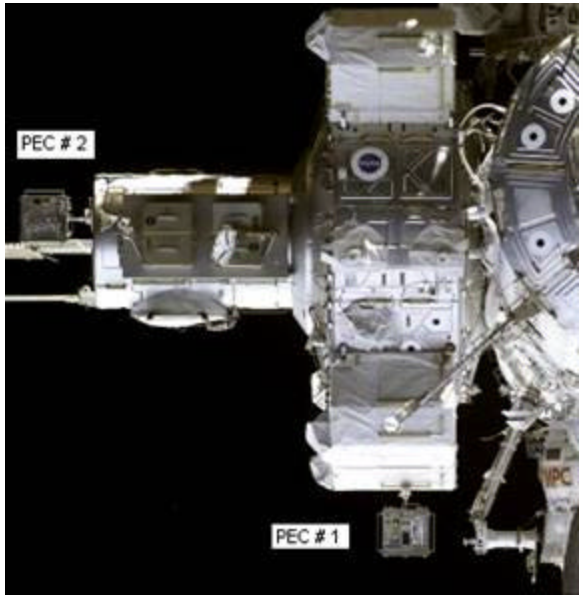


## ETVCG & VSSA

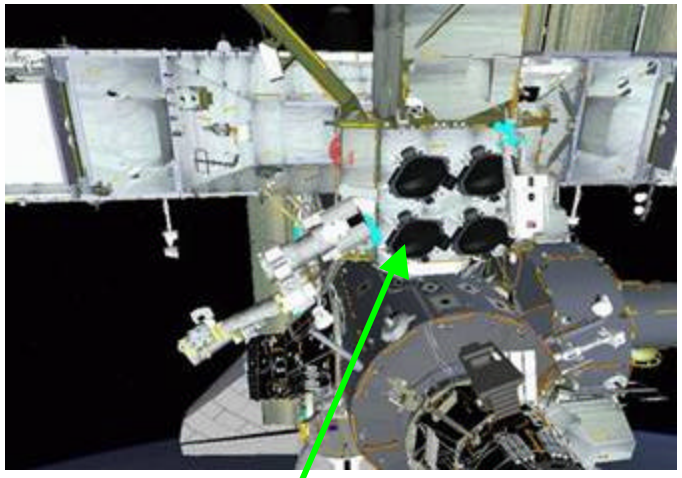


## CMG in FSE





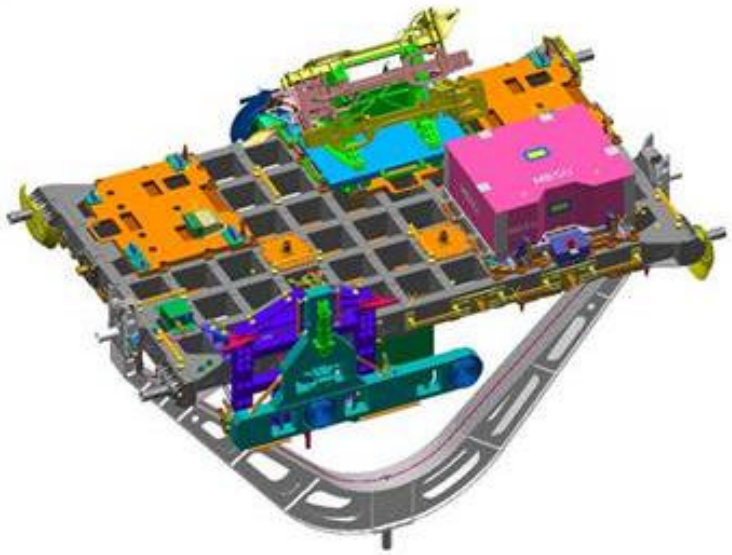

MISSE PECs 1 & 2



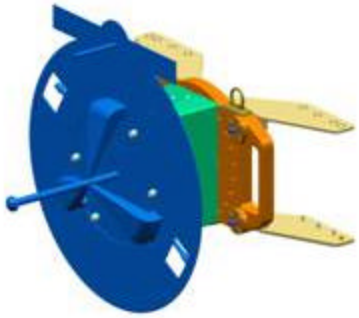
CMG R&R

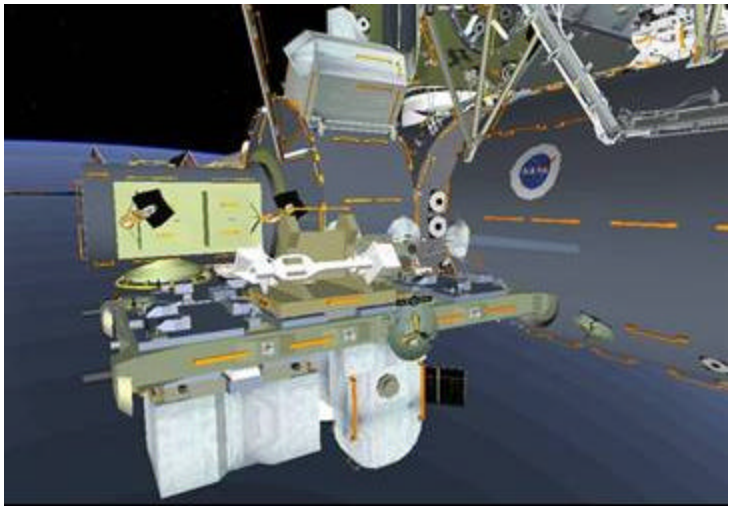
# Back-up Charts

## ESP-2 Launch Configuration



## ESP-2 Grapple Fixture





ESP-2 On-orbit Configuration

# BACKUP

# CIPAA Flight Units Schedule

- Two flight units currently in Denver
- 6/29 – Fill both flight units with CIPA
- 7/2 – Implement any design change no later than this date
- 7/3 – Ship both CIPAAs to KSC on dedicated truck
- 7/5-6 – KSC receiving/logistics
- 7/7-8 – Post shipment checkout, installation of MLI and final acceptance tests
- 7/11 – L-3 crew review and final bagging of CIPAA for flight.
- 7/12 – L-2 stow of CIPAAs

# Part B Containment Summary

- **Consists of four physical layers**
  - CIPAA provides one level of containment with poly-pack seals inside part B reservoir.
  - CIPAA is placed in a Nomex/VBS ‘sock’. The VBS blanket in the sock absorbs any A-1100 leakage that is external to the CIPAA. (not shown in pictorial)
  - CIPAA and Nomex/VBS sock are placed inside 2 tedlar bags. Each bag is vented with a chemical filter (VBS is the filter material)
- **Tedlar bag sample port allows for sampling via ethanol draeger tubes to check for the presence of A-1100 prior to opening the bags**